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AUG 26 2008

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SUBJECT: FINAL TECHNICAL MEMORANDUM ASSESSING SELENIUM CONCENTRATIONS IN CLAY REMAINING AFTER EXCAVATION OF CONTAMINATED SEDIMENTS, REVISION 1, INSTALLATION RESTORATION PROGRAM SITE 27, FORMER NAVAL AIR STATION MOFFETT FIELD, MOFFETT FIELD, CALIFORNIA

Dear Ms. Lee and Ms. Wells:

We are pleased to transmit the Revision 1 Final Technical Memorandum Assessing Selenium Concentrations in Clay Remaining after Excavation of Contaminated Sediments, Revision 1. This technical memorandum addresses selenium concentrations reported above the laboratory detection limits in clay within the Northern Channel, Marriage Road Ditch, and North Patrol Road Ditch in the vicinity of the Building 191 lift station at Installation Restoration Program (IRP) Site 27, located at the former Naval Air Station Moffett Field, Moffett Field, California (Enclosure 1).

If you have any questions, please contact Mr. Mark Walden, Navy Project Manager at (619) 532-0931, or me at (619) 532-0963.

Sincerely,

DARREN NEWTON
BRAC Environmental Coordinator
By direction of the Director

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Enclosure: 1. Final Technical Memorandum Assessing Selenium Concentrations in Clay Remaining after Excavation of Contaminated Sediments, Revision 1, Installation Restoration Program Site 27, Former Naval Air Station Moffett Field, Moffett Field, California, 26 August 2008

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CTO No. 0004

FINAL

TECHNICAL MEMORANDUM ASSESSING SELENIUM CONCENTRATIONS IN CLAY REMAINING AFTER EXCAVATION OF CONTAMINATED SEDIMENTS

Revision 1

August 26, 2008

DCN: ECSD-2201-0004-0002.R1

INSTALLATION RESTORATION PROGRAM SITE 27
FORMER NAVAL AIR STATION MOFFETT FILED
MOFFETT FIELD, CALIFORNIA

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CONTRACT NO. N62473-06-D-2201
CTO NO. 0004

FINAL

TECHNICAL MEMORANDUM ASSESSING SELENIUM CONCENTRATIONS IN CLAY REMAINING AFTER EXCAVATION OF CONTAMINATED SEDIMENTS

Revision 1

August 26, 2008

INSTALLATION RESTORATION PROGRAM SITE 27
FORMER NAVAL AIR STATION MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA

DCN: ECSD-2201-0004-0002.R1

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TABLE OF CONTENTS

PAGE

ATTACHMENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

AEL	allowable exposure level
ATC	aquatic transfer coefficient
BRAC	Base Realignment and Closure
BTF	biotransfer factor
COEC	chemical of ecological concern
FS	feasibility study
GIS	Geographic Information System
mg/kg	milligrams per kilogram
ORP	oxidation/reduction potential
PCB	polychlorinated biphenyl
PMO	Program Management Office
ROD	Record of Decision
TCG	target cleanup goal
TtEC	Tetra Tech EC, Inc.
TtEMI	Tetra Tech EM, Inc.
UCL	upper confidence limit

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1.0 INTRODUCTION

This Technical Memorandum addresses selenium concentrations reported above the laboratory detection limits in clays within the Northern Channel, North Patrol Road Ditch, and Marriage Road Ditch. Selenium concentrations in clays are assessed in light of cleanup requirements and goals that were established in the Record of Decision (ROD) for overlying sediments for the remedial action at Site 27, at the former Naval Air Station Moffett Field (Moffett), Santa Clara County, California. On behalf of the Department of the Navy's (Navy's) Base Realignment and Closure (BRAC) Program Management Office (PMO) West, this Technical Memorandum has been prepared by Tetra Tech EC, Inc. (TtEC) under Remedial Action Contract No. N62473-06-D-2201, Contract Task Order No. 0004, and Contract No. N68711-98-D-5713, Contract Task Order No. 0098.

1.1 BACKGROUND

The Navy conducted remedial activities at Site 27 as part of the Installation Restoration Program at Moffett. Site 27 consists of the Northern Channel, including the western portion (first 800 linear feet) of the north and south slopes of the Northern Channel and the Lockheed Martin Space System Company berm near the eastern end of the Northern Channel; the Marriage Road Ditch; the North Patrol Road Ditch; and the debris pile near the Building 191 lift station (Figure 1-1). The purpose of these channels is to move stormwater off of and away from Moffett. Ultimately, this water discharges to San Francisco Bay north of the site.

The Navy had previously conducted several investigations at Site 27 and determined upon evaluation of the site-specific data that Site 27 contains sediments and soils with elevated concentrations of certain chemicals of ecological concern (COECs), including polychlorinated biphenyls (PCBs), pesticides, and metals. The surface water has been analyzed on several occasions and is not considered a medium of concern (Tetra Tech EM, Inc. [TtEMI], 2003). The Navy conducted a feasibility study (FS) (TtEMI, 2003) to evaluate the potential remedial alternatives for the Site 27 sediments and soils and prepared a ROD (BRAC PMO West, 2005) to document the selected remedy for the site.

The Navy has developed a Final Remedial Action Work Plan (TtEC, 2006a) to describe activities associated with implementation of the remedy selected for Site 27, and the work has been completed.

1.2 PROBLEM STATEMENT AND TECHNICAL MEMORANDUM OBJECTIVE

The primary remedial action objective for this remedial action, as identified in the ROD, was to reduce direct exposure of ecological receptors to the Site 27 COECs in sediments to levels that are protective of birds in the Northern Channel and related areas. The respective cleanup goals for selenium in the sediments as identified in the ROD (BRAC PMO West, 2005) are as follows:

- 0.926 milligram per kilogram (mg/kg) for site sediments (assumed to be submerged within the channels)
- 390 mg/kg for the berms (assumed to be located above water)

Excavations have been conducted in accordance with the Final Remedial Action Work Plan (TtEC, 2006a) in the Northern Channel, Marriage Road Ditch, and North Patrol Road Ditch. Approximately 65,000 cubic yards of sediments was excavated and disposed of off site. Confirmation sampling results from samples collected in clays underlying the removed sediments in the Northern Channel, Marriage Road Ditch, and North Patrol Road Ditch indicated that selenium concentrations were above the sediment cleanup goal.

The purpose of this Technical Memorandum is to provide an explanation of the relevant issues and the rationale to support a decision of no further excavation of clay with selenium concentrations above the existing sediment cleanup goal.

2.0 REQUIREMENTS OF THE ROD

To achieve the remedial action objective, the scope of the selected remedy was outlined in the ROD as follows:

- Excavate sediments in areas where concentrations of COECs exceed cleanup goals considered safe for birds, such as the great blue heron and the black-necked stilt, which are considered the most sensitive ecological receptors likely to be present in the Northern Channel and related areas given site uses. Excavate soil where soil concentrations exceed the residential preliminary remediation goals.
- Transport excavated sediments and soil off site to an appropriate disposal facility.
- Collect confirmatory samples in the excavation areas to ensure that sediment and soil exceeding cleanup goals have been removed in accordance with the guidelines established in the ROD.
- Restore the site by 1) backfilling the excavated areas of the berms with clean soil (free from contaminants), 2) backfilling the excavated areas of the Northern Channel and associated ditches (as needed) to maintain the hydrologic conditions, and 3) revegetating berms with plants native to California.

It should be noted that the Regional Water Quality Control Board requested site restoration activities be modified so no backfill materials were placed within the Northern Channel or associated ditches, as discussed in the Final Remedial Action Work Plan (TtEC, 2006a). In addition, hydroseeding with a native California seed mix, where appropriate, was conducted instead of revegetating the berms with plants (TtEC, 2006b).

The final ROD (BRAC PMO West, 2005, p. 69) indicates that the extent of the excavation within the Northern Channel, North Patrol Road Ditch, and Marriage Road Ditch will only include the sediments, and that confirmation sampling and visual inspection of the clay layer in the excavation will be used to confirm that the response action has been completed in compliance with the ROD (i.e., once sediments are removed).

The TtEC site geologist has confirmed, based on visual observations, that the sediments have been removed as required by the ROD (Richards, 2006). Thus, even though selenium concentrations in the clays exceed cleanup goals in some cases, the remedial action has been completed in accordance with the ROD.

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3.0 ADDITIONAL ANALYSIS

Selenium concentrations in the confirmation samples collected at the Northern Channel, Marriage Road Ditch, and North Patrol Road Ditch are presented in Tables 3-1, 3-2, and 3-3, respectively. All confirmation samples were collected from the clay beneath the sediments. As shown in Tables 3-1, 3-2, and 3-3, a total of 212 confirmation samples were collected from the Northern Channel, 45 from Marriage Road Ditch, and 80 from North Patrol Road Ditch. Selenium was reported at levels exceeding the sediment cleanup goal of 0.926 mg/kg in only 3 of the 45 samples collected from the Marriage Road Ditch. However, 64 of the 212 samples from the Northern Channel, and 46 of the 80 samples from the North Patrol Road Ditch had selenium at levels exceeding the sediment cleanup goal. Selenium concentrations with a "J" qualifier (estimated value) are considered to be a valid value for this Technical Memorandum. Selenium concentrations with a "U" or "UJ" qualifier were not detected (non-detects) at the laboratory reporting level. The concentrations of confirmation samples exceeding the cleanup goal are shown by location on Figure 3-1.

For the Northern Channel, selenium concentrations within the clay ranged up to an estimated value of 7.2 J mg/kg, exceeding the sediment cleanup goal by up to 6.3 mg/kg. Marriage Road Ditch confirmation sample concentrations ranged up to 1.7 mg/kg, exceeding the sediment cleanup goal by up to 0.77 mg/kg. North Patrol Road Ditch confirmation sample concentrations ranged up to 6.3 mg/kg, exceeding the sediment cleanup goal by up to 5.4 mg/kg.

For comparison, selenium results for in situ sediment samples collected for waste characterization purposes prior to excavation activities at the Northern Channel, Marriage Road Ditch, and North Patrol Road Ditch are summarized in Tables 3-4, 3-5, and 3-6, respectively. Selenium concentrations in these sediment samples ranged up to 43 mg/kg. Additional information to support the conclusion that the presence of selenium in the impacted clays is naturally occurring is presented in the following sections.

3.1 SELENIUM DETECTIONS IN CLAY LIKELY REFLECT NATURALLY OCCURRING SELENIUM

Selenium was not used in the context of any known historical mission at Moffett. In addition, selenium occurs naturally in soils and is known to be present in local and regional soils in and within the vicinity of Moffett at comparable concentrations. Since the Northern Channel and associated ditches have received runoff from the area for decades, it is plausible that this runoff may be the main source of elevated selenium levels in sediments, and that the selenium in the underlying clays is most likely naturally occurring. The following sections discuss the presence of selenium in different locations.

3.1.1 Selenium in Regional and Local Soils

Selenium occurs naturally and is widely dispersed in the earth's crust. U.S. Geological Survey researchers report a nationwide range of soil selenium concentrations of 0.1 to 4.3 mg/kg (Shacklette and Boerngen, 1984). Elevated levels of selenium have been widely reported in agricultural drainage waters in California's Central Valley, and have been attributed to seleniferous shales of marine origin that influence a significant portion of soils in coastal areas and mountains on the west side of the valley (Fuji et al., 1988). Bedrock in the Santa Clara Valley has been shown to contain marine shales (Anderson, 1998), and thus it is likely that South Bay area soils contain elevated levels of naturally occurring selenium.

Several studies were reviewed to discern background selenium levels in soils specific to the Mountain View area. Analytical data for soil were evaluated to determine natural background levels or baseline concentrations of selected metals, including selenium, in an area of northern Santa Clara County approximately 5 to 10 miles east of Mountain View (Scott, 1995). The data were derived from environmental investigation reports prepared by independent researchers under government regulatory agency oversight. Selenium was reported in 16 of 108 samples analyzed (detection limits reportedly ranged from 0.2 to 4 mg/kg), at concentrations of up to 4 mg/kg (15 percent detection frequency). In addition, selenium was reported in samples collected near the Guadalupe River at a lower frequency, but at concentrations up to 8 mg/kg.

Selenium was reported in the clay following sediment removal in a total of 170 of 337 samples (all excavated areas), which is a detection frequency of 50 percent. This is higher than the detection frequency derived from data presented by Scott (1995). It should be noted that the impact of the detection limits on detection frequency in the cited reports is not clear. For example, as can be seen in Tables 3-1, 3-2, and 3-3, 104 of the 113 confirmation samples (all three sites) with selenium concentrations in excess of the cleanup goal had concentrations below 4 mg/kg. Scott (1995) reported that, for the data presented, detection limits ranged up to 4 mg/kg. Accordingly, for analyses where detection limits were 4 mg/kg, selenium would not have been detectable at concentrations comparable with most of the confirmation sample concentrations (i.e., 0.9 to 3.7 mg/kg). Therefore, it is not clear whether more samples from the cited studies contained selenium at levels below a detection limit of 4 mg/kg.

3.1.2 Selenium in Debris Pile Samples

Following excavation activities, soil (clay) samples were also collected in the area known as the debris pile (refer to Figure 1-1), which is not subject to conveyance of stormwater, as are the sediments and clays underlying the channel and ditches. Based on visual observation, samples collected from the debris pile area consisted of the same clay that is present in the channel/ditch bottoms. As noted above, selenium was not used in any known historical mission at Moffett. Furthermore, the debris pile area was not a chemical waste disposal area, as the debris consisted of construction debris (mostly rock, roofing, concrete, and wood). No pesticides were reported in any debris pile samples, and while metals occur naturally in soils, reported concentrations

were well below respective target cleanup goals (TCGs). Only one COEC (a PCB) was reported in only one debris pile sample. Therefore, clay samples from the debris pile would be expected to show minimal impact from external sources of contamination, and it is reasonable to conclude that the debris pile samples provide a comparable reference point for the clays in the channel/ditches.

To assess the selenium concentrations in the debris pile area, eight confirmation samples were collected in clays from this area, and selenium concentrations were reported as follows: 1.4, 0.92, 5.7, 0.45, 0.96, 2.0, 3.3, and 0.42 mg/kg. These data show that: 1) selenium was present in all eight clay samples, 2) selenium concentrations exceeded the sediment cleanup goal in five of the eight samples, and 3) the selenium concentration was very close to the cleanup goal in one of the other two samples in which it was reported. The fact that selenium was reported at a high frequency in clay samples that were not subject to constant contact with stormwater at concentrations comparable to clays underlying the channel and ditches provides support that selenium in clays underlying the channels and ditches did not result from deposition due to storm runoff; rather, it is likely naturally occurring.

3.1.3 Selenium Data from the Moffett GIS Database

To date, background metals levels have not been rigorously assessed at Moffett. However, a database known as the Moffett Geographic Information System (GIS) database has already been created for the site. The GIS database contains site-wide soil and sediment data (including selenium) collected between 1986 and 2004 from four historical sources: National Aeronautics and Space Administration, Middlefield-Ellis-Whisman (a Potentially Responsible Party group south of Highway 101), TtEMI, and TtEC. Results in the database encompass a wide range of soil/sediment types and depths across the site, and thus provide information regarding site-wide selenium levels. Accordingly, a query was conducted to generate all selenium concentrations for all soil and sediment samples contained within the database. The goal of this exercise was as follows:

- Obtain information on the selenium detection frequency and concentrations in local soils and sediments using existing data relevant to selenium levels in clay confirmation samples.

The following points should be considered for selenium concentration assessment:

1) The query specified all detected and not detected results for soil and sediment sample data that are considered valid/usable data, and all values are reported in dry weight units (field duplicates were not included). Data considered nonvalid/nonusable were rejected by a third-party data validation effort.
2) It is acknowledged that the investigations that yielded these data were not conducted specifically to assess "background" concentrations, and thus the selenium data cannot explicitly be considered as such.

3) The selenium data are assumed to be reasonably random and representative of natural conditions, because selenium has never been used or identified as a contaminant on site. It was routinely analyzed for as part of a suite of metals, and no investigations have been conducted to specifically identify or define an area of selenium contamination (i.e., this assumption would not be valid in the case of known contaminants that are specifically targeted for detection/evaluation).

4) The data are from samples collected during a wide range of investigative activities. While most of the results have associated coordinates, it is beyond the scope of this effort to attempt to factor sample location and/or depth into the analysis.

5) The results were collected over an 18-year period, and detection limits varied widely based on analytical methodology, matrix interferences, project-specific requirements, etc. The initial query yielded 2,183 results for selenium, with almost half of the concentrations reported as not detected. However, many of the reporting limits were well above the cleanup goal (0.926 mg/kg) with a maximum reporting limit of 43.9 mg/kg. For the Northern Channel remedial action, confirmation sample results exceeding the cleanup goal in the clay underlying the sediments were mostly in the range of 2 to 3 mg/kg, with a maximum of 7.2 mg/kg. The high detection limits associated with many of the queried results render them useless in assessing selenium concentrations in this range, because selenium may be present at these concentrations but would not be detected/reported (over 500 results were "not detected" with reporting limits greater than 10 mg/kg). Thus, to present and assess the data in a manner specific to this investigation, the concentrations reported as not detected with a reporting limit above the cleanup goal of 0.926 mg/kg were filtered out. This left 1,287 sediment and soil samples in which selenium was either detected or was not detected with a detection limit below 0.926 mg/kg. The retained not detected results with detection limits below the cleanup goal were plotted as the detection limit. This is deemed sufficient for the goal set forth above.

Relevant statistics are presented below:

Summary Statistics for Historical Selenium Detects in Soils and Sediments
(concentrations in mg/kg, dry weight basis).

Sample Type	Number of Samples	Mean Selenium Concentration	Median Selenium Concentration
Sediment and Soil	1,287	1.42	0.55
Soil only	942	1.56	0.53
Sediment only	345	1.03	0.61

The data were plotted for sediment and soil (Figure 3-2), soil alone (Figure 3-3), and sediment alone (Figure 3-4) as quantities with two concentration scales: a full scale plot with concentrations ranging from the detection limit to maximum, and a subset showing concentrations ranging from the detection limit to 5 mg/kg. The data show that selenium has been reported above the detection limit in both the soil and sediments, at levels comparable with the levels reported in clay confirmation samples collected in the Northern Channel and associated ditches. For the combined sediment and soil samples, selenium was reported

at concentrations exceeding the cleanup goal in approximately 25 percent of the samples (Figure 3-2). Approximately 20 percent of the soil samples and approximately 35 percent of sediment samples had selenium at concentrations exceeding the cleanup goal (Figures 3-3 and 3-4, respectively).

3.1.4 Summary of Selenium Occurrence

It is well established that selenium occurs naturally in regional and local soils in and around the Moffett area. This has been documented through various investigations, some of which are summarized above. Based on the available information, it is likely that over many years, surface runoff washed selenium from naturally occurring sources into the Northern Channel and associated ditches. The selenium migrated into and was sequestered within the sediments, and accumulated in reduced and unavailable forms. In addition, underlying clays appear to contain naturally occurring selenium. In light of this information, and because selenium was not used in the context of any known historical mission at Moffett, it is a reasonable conclusion that selenium concentrations in the clays underlying the Northern Channel and associated ditches are naturally occurring.

3.1.5 Investigation into the Forms of Selenium

Selenium forms a variety of compounds, each with different properties in terms of fate, transport, and toxicity. The forms of selenium most commonly leached from marine shales include the oxyanions selenate and selenite. Both of these soluble and mobile species are toxic, are easily transported via surface flow, and can migrate into soils and sediments based on a vertical gradient. Further, by virtue of their solubility and toxicity, these are the forms that are considered to represent a threat to environmental receptors.

The environmental fate of selenium is controlled by several factors, including pH, oxidation/reduction potential (ORP), complexing ability of soluble and solid ligands, biological interactions, and reaction kinetics (Barrow and Whelan, 1989; McNeil and Balestrieri, 1989). Of these, ORP is generally the major controlling influence in most terrestrial systems (Masscheleyn et al., 1990). In reducing environments, selenate and selenite are reduced to form insoluble elemental selenium and other insoluble species (Hem, 1985). Elemental selenium is the major product of dissimilatory reduction by selenate-respiring microorganisms (in the presence of an organic electron donor), which are ubiquitous in nature (Oremland et al., 1991). Accordingly, selenium has been shown to accumulate in sediments in reducing environments such as wetland channels (Zhang and Moore, 1998). The continuously flooded conditions in the Northern Channel, along with the likely presence of organic matter in the runoff water, indicate the likelihood that reducing conditions predominate in the clays that line the channels. Thus, it is likely that selenium present in the clays is in insoluble forms and largely unavailable to aquatic receptors.

To investigate this further, clay samples were collected on November 7, 2006, and subjected to laboratory speciation analysis to compare the ratio of selenate and selenite to total selenium. This

analysis provides conclusive insight as to whether selenium is present as soluble, toxic forms or reduced and largely insoluble forms. Six clay samples were collected at random points from three locations in the Northern Channel at two discrete depths: 12 and 18 inches below ground surface. The samples were split, and aliquots were extracted with a potassium phosphate buffer. The supernatant was then filtered and analyzed directly for selenate and selenite via ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry. Paired aliquots were also digested using a closed vessel nitric acid bomb digestion. The digested samples were analyzed for total selenium by inductively coupled plasma dynamic reaction cell mass spectrometry. Results of the analysis are presented in Table 3-7. The laboratory report is included as Attachment 1.

The data in Table 3-7 show that total selenium levels in these clay samples ranged from 1.31 to 2.62 mg/kg, which are consistent with the concentrations previously measured in the confirmation samples (refer to Tables 3-1, 3-2, and 3-3). The data also show that neither selenate nor selenite was reported in the clay samples. This provides direct evidence that selenium in the clay is not present as the toxic, soluble selenate and selenite, but rather as reduced forms, which are largely insoluble. In addition, the fact that selenium was present at depth in the clays (up to 18 inches deep) supports the assertion that it is likely to be a natural constituent of these clays.

It is acknowledged that the speciation analysis was not conducted on the surface clay samples, and although probable, it cannot be definitively concluded that the selenium in the surface clays is present in insoluble forms. However, given that the surficial clays are constantly flooded, and ample organic matter is present, anoxic conditions likely predominate. Thus, it is reasonable to conclude that selenium in surficial clays is in a reduced, insoluble form.

It should also be noted that reduced, immobile forms of selenium may undergo oxidation to soluble forms under oxidizing conditions. Oxidation of a portion of the insoluble selenium fraction has been reported in laboratory studies designed to mimic field conditions using soils from Kesterson Reservoir (Zawislanski and Zavaran, 1996). However, this is expected to be of minimal significance at Site 27.

Under the current conditions in the channel and ditches (flooded, reduced conditions), reoxidation would be extremely limited (this is supported by the fact that no soluble species were reported in any of the clay samples at detection limits of 0.001 to 0.003 mg/kg). For oxidation to occur to any significant degree, soils must be well aerated and kept moist. However, depending on the organic content of the soils, too much moisture (i.e., water) may lead to generation of anaerobic conditions, which are not supportive of oxidation reactions. Even under conditions where the soil cycles back and forth between dry and wet, oxidation of elemental selenium is believed to be relatively slow (Zawislanski and Zavaran, 1996), whereas reduction of solublized selenium species can occur in a matter of hours (Tokunaga et al., 1996).

The only way reoxidation of selenium could possibly be a consideration at this site is if the land use were to change, and the clays were somehow disturbed and regraded as surface soils (dried and exposed) and subjected to aeration while maintaining moist conditions. According to the Navy, current site conditions are not likely to change in the foreseeable future, and it is thus highly likely that the clays underlying the channel and drainage ditches will remain as they have in the past, basically under flooded conditions. However, in the unlikely event that the site is disturbed as described and oxidizing conditions are generated and maintained, some portion of the insoluble selenium pool would likely be oxidized over time to soluble forms (Zawislanski and Zavaran, 1996). However, Zawislanski and Zavaran (1996) further reported that some fractions are likely to remain biologically unavailable for decades.

Finally, it is important to note that according to the ROD, the TCG of 0.926 mg/kg for selenium in sediments is intended to be protective of birds in the Northern Channel and related areas (ditches), and is applicable to submerged sediments that line the bottom of the channel and ditches. If the land use were to change significantly as described above, and the channels were drained, excavated, and regraded for an alternate land use, the TCG of 0.926 mg/kg for selenium would no longer apply. Rather, the ROD-specified selenium TCG of 390 mg/kg for the soils on the berm, which are under dry, exposed conditions, would apply. This value is based on the residential preliminary remediation goals (PRGs) and would be considered protective of the environment in this case, regardless of whether reoxidation of reduced selenium species occurred.

3.2 DETECTED SELENIUM CONCENTRATIONS IN CLAY ARE LIKELY PROTECTIVE OF THE ENVIRONMENT

The 0.926 mg/kg cleanup goal (allowable exposure level [AEL]) for selenium in sediment is based on the great blue heron and was calculated using a conservative bioaccumulation factor derived from the literature (termed the "Aquatic Transfer Coefficient" or "ATC" in TtEMI, 2003) rather than the site-specific bioaccumulation factor derived from fish and sediment samples collected at the site (termed the "Biotransfer Factor" or "BTF" in TtEMI, 2003). The ATC and the BTF are both calculated by taking the ratio of the concentration of the contaminant in fish compared to the concentration of the contaminant in sediment. A review of these bioaccumulation factors for fish indicates that a less conservative bioaccumulation factor could be used while still being protective of the environment. The derivation of the bioaccumulation factors is discussed below, as well as potential alternate bioaccumulation factors that could be used to derive an AEL for the great blue heron. It is noted that the purpose of this section is to provide a more realistic evaluation of the site-specific risk; it is not meant to replace the existing risk assessment.

3.2.1 Derivation of the Fish Bioaccumulation Factors

The AEL for selenium in sediment is based on protection of the great blue heron, a fish-eating bird. The AEL was calculated using an ATC of 31.9. As discussed in the Northern Channel FS

(TtEMI, 2003), the ATC was derived specifically from a study conducted at Kesterson Reservoir and other locations in Merced County, California (Saiki and Lowe, 1987). The study measured selenium concentrations in sediment and mosquitofish, as well as in other components of the aquatic environment.

The site-specific BTF of 0.412 was derived from sediment and fish samples collected at the site. A total of 12 fish samples and 15 collocated sediment samples were collected at 15 transects along the entire length of the Northern Channel. Four species of fish were collected, including mosquitofish, longjaw mudsucker, three-spined stickleback, and top smelt. The results showed that the selenium concentrations in fish were low, as the 95 percent upper confidence limit (UCL) concentration was 0.7 mg/kg (dry weight). The BTF was based on the 95 percent UCL of the measured concentrations. The BTF is approximately 77 times less than the ATC.

The difference between the ATC and BTF values may be due to the differences in the bioavailabilty of selenium at Kesterson as compared to the Northern Channel. The extent of the bioaccumulation of selenium in fish is directly affected by its bioavailability in the aquatic environment. Bioavailability is influenced by a large number of environmental factors as well as chemical and physical properties, such as the form of selenium (reduced forms are generally less bioavailable), the pH of the sediment and water column, sediment particle size, presence of organic matter, concentrations of sulfides, salinity, and temperature (Luoma and Rainbow, 2005; John and Leventhal, 1995). The selenium is likely in a reduced form and bound up in the clays beneath the sediments. It has also been shown that bioaccumulation in fish in lentic environments (e.g., lakes, ponds) is higher than in lotic environments (e.g., rivers, streams) (Nagpal, 2001). The Northern Channel is an estuarine environment, whereas Kesterson is freshwater, so this alone likely results in some differences in bioavailability.

Bioaccumulation is also influenced by the biological characteristics of the organisms being evaluated. In the case of fish, this can include a number of factors such as diet, feeding habits, and percent body fat (lipids). The Kesterson study evaluated only mosquitofish, whereas the BTF for the Northern Channel was based on mosquitofish and the three other fish species previously mentioned.

Given the number of factors that affect bioavailability and bioaccumulation, a bioaccumulation factor based on site-specific samples (i.e., the BTF) is more appropriate than a bioaccumulation factor taken from another site (i.e., the ATC). A site-specific bioaccumulation factor takes into account the sediment and water quality properties and biological factors that affect bioaccumulation.

In reviewing the Kesterson study (Saiki and Lowe, 1987), a median bioaccumulation factor for fish of 5.5 was derived based on 14 paired samples of fish and sediment. Similar bioaccumulation factors were derived using fish and sediment data cited in several other studies in the literature. Using fish and sediment data from a study of selenium in the Salton Sea, a

bioaccumulation factor of 3.3 (Salton Sea Authority, n.d.) was estimated. Using data from a study of selenium in streams in Idaho, a bioaccumulation factor of 4.9 (Hamilton et al., 2002) was estimated. The review of these studies further supports the use of a more moderate bioaccumulation factor in calculating the AEL for the great blue heron.

3.2.2 Calculation of Alternate Cleanup Level for the Great Blue Heron

Fish samples collected in the Northern Channel indicate that selenium concentrations in fish were quite low as a result of minimal accumulation from sediment. These low values in the fish support the idea that the selenium is more isolated from the receptor population as reflected by the difference between ambient selenium concentrations in the ditch relative to actual uptake in the fish. Therefore, it appears to be appropriate to use a moderate bioaccumulation factor as the necessary measure of conservatism. The most conservative bioaccumulation factor of the studies cited above was selected.

Using the median bioaccumulation factor (5.5) derived from the Saiki and Lowe (1987) study and the methodology presented in Table 2-16 in the Northern Channel FS, a ditch-specific selenium AEL of 5.27 mg/kg is calculated that is still protective of the great blue heron. Importantly, this ditch-specific AEL is not intended to replace the sediment cleanup goal originally calculated and presented in the ROD. Rather, it is intended to provide a clearer view of the site-specific risks represented by leaving the clay bottom of the excavated channel and associated ditches intact.

3.2.3 Implications with Respect to Selenium Levels in Confirmation Samples

This section discusses the potential risks associated with the confirmation samples for the great blue heron and the other avian receptors that were evaluated in the Northern Channel FS – the mallard and the black-necked stilt.

<u>Great Blue Heron.</u> The maximum selenium concentrations in confirmation samples collected in the clay layer from the Northern Channel and Marriage Road Ditch are 7.2 J and 1.7 mg/kg, respectively. In the Northern Channel only 4 of the 212 samples (less than 2 percent) had selenium concentrations greater than the ditch-specific AEL of 5.27 mg/kg; the concentrations exceeding the AEL are 5.7, 6.0, 6.6, and 7.2 J mg/kg. In the Marriage Road Ditch, all 45 samples had selenium concentrations less than the ditch-specific AEL of 5.27 mg/kg. In the North Patrol Road Ditch, only 3 of 80 samples (less than 4 percent) had selenium concentrations greater than the ditch-specific AEL; the concentrations exceeding the AEL are 5.7, 5.9, and 6.3 mg/kg. However, evaluation of potential risk to the great blue heron focuses on the average exposure to selenium that the bird would receive over its foraging range. Therefore, average concentrations of selenium in their environment (i.e., in sediments and fish) are used, not specific maxima. It is standard practice in risk assessment to calculate the 95 percent UCL concentration to represent a conservative estimate of the average exposure concentration. This was done in the ecological risk

evaluation presented in Section 2.0 of the Northern Channel FS, where a 95 percent UCL was used to estimate the exposure point concentration used in the risk calculations.

To further evaluate the potential risk to the great blue heron, 95 percent UCL[1] values were calculated for the Northern Channel and the North Patrol Road Ditch. A 95 percent UCL was not calculated for Marriage Road Ditch because all of the samples were less than the AEL. The 95 percent UCL for the Northern Channel is 1.25 mg/kg, which indicates that the average exposure to the great blue heron is well below the ditch-specific AEL of 5.27 mg/kg and selenium would not present a risk to the great blue heron. The 95 percent UCL for the North Patrol Road Ditch is 1.89 mg/kg. Again, this concentration is well below the ditch-specific AEL of 5.27 mg/kg and indicates that the concentration of selenium in the North Patrol Road Ditch would not present a risk from potential exposure to selenium. Thus, the three exceedances of the ditch-specific AEL in the North Patrol Road Ditch are not of consequence with respect to potential risk to the great blue heron because they are accounted for in the computation of the 95 percent UCL. As such, they do not require removal, and further excavation is not warranted.

<u>Mallard.</u> The AEL for the mallard is 7.83 mg/kg. The maximum concentrations of selenium in the confirmation samples collected in the clay layer of the North Patrol Road Ditch, Marriage Road Ditch, and the Northern Channel are 6.3, 1.7, and 7.2 J mg/kg, respectively. The maximum concentrations are all less than the AEL and thus do not present a risk to the mallard.

<u>Black-Necked Stilt.</u> The AEL for the black-necked stilt is 1.99 mg/kg. The maximum concentration of selenium in the 45 confirmation samples collected in the clay layer of Marriage Road Ditch (1.7 mg/kg) is below the AEL and does not present a risk to the black-necked stilt. The maximum selenium concentrations in the North Patrol Road Ditch (6.3 mg/kg) and the Northern Channel (7.2 J mg/kg) exceed the AEL. A single sample exceeding the AEL by a small margin (e.g., 2 or 4 times) does not indicate that there is a risk to the black-necked stilt. However, because of these exceedances, it is appropriate to take into consideration the results of the other samples and the 95 percent UCL to further evaluate potential risks in the North Patrol Road Ditch and the Northern Channel.

The 95 percent UCLs for the North Patrol Road Ditch and the Northern Channel are 1.89 and 1.25 mg/kg, respectively. The UCLs are both less than the AEL, and therefore the average concentrations to which the black-necked stilt may be exposed in these areas are not expected to pose a risk.

Sixteen percent of the confirmation samples (13 of 80 samples) in the North Patrol Road Ditch exceed the AEL for the black-necked stilt, with concentrations ranging from 2.0 to 6.3 mg/kg. These concentrations exceed the AEL of 1.99 mg/kg by up to 3.2 times. The exceedances are

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[1] All of the 95 percent UCLs in this section of the Technical Memorandum were calculated using the U.S. Environmental Protection Agency's ProUCL program, Version 4.0. Half the reporting limit was used for those samples that were below the reporting limit (i.e., non-detects).

located in two areas of the ditch; one area is near Marriage Road and the other area is about 500 to 800 feet west of Marriage Road. These two areas have a total length of about 500 feet. This represents only a small portion of the 4,300-foot length of the ditch (approximately 12 percent). Given the small magnitude of the exceedances (about 3.2 times or less) and the small area they represent, it is unlikely that these concentrations of selenium would pose a risk to the black-necked stilt. Furthermore, the 95 percent UCL (1.89 mg/kg) is below the AEL, and thus the average exposure concentration does not pose a risk.

Approximately 12 percent of the confirmation samples (26 of 212 samples) in the Northern Channel exceed the AEL for the black-necked stilt, with concentrations ranging from 2.0 to 7.2 J mg/kg. These exceedances are less than 3.6 times greater than the AEL of 1.99 mg/kg. These samples are widely distributed along the Northern Channel, from approximately the location of Marriage Road to the east end of the channel, with the higher concentrations located near the east end of the ditch (Figure 3-1). Given the small magnitude of the exceedances (up to 3.6 times) and the low percentage of samples that exceed the AEL (12 percent), it is unlikely that these concentrations of selenium would pose a risk to the black-necked stilt. Furthermore, the 95 percent UCL (1.25 mg/kg) is below the AEL and thus the average exposure concentration does not pose a risk to the black-necked stilt.

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4.0 SUMMARY AND CONCLUSIONS

In summary, a remedial action, consisting of excavating contaminated sediments from drainage channels, was conducted in accordance with the selected remedy prescribed in the ROD. Selenium was reported at concentrations exceeding the site-specific cleanup goal established for sediments in confirmation samples. The confirmation samples were collected in the underlying clay layer following the excavation of sediments from the Northern Channel, Marriage Road Ditch, and North Patrol Road Ditch. According to the ROD, only excavation of sediments is prescribed, and confirmation sampling (interpreted as confirmation that any sediments left in place would have COECs below the cleanup level) and visual identification of the clay layer are to be used to confirm that the response action has been completed (BRAC PMO West, 2005).

Selenium has not been identified as ever having been used at the site, and existing data suggest that selenium occurs naturally in soils in the surrounding area. Additional sampling and analysis were also conducted, in which clay samples were collected randomly along the Northern Channel and analyzed for both soluble and total selenium. Results of the analysis showed that the major soluble forms (selenate and selenite) were not present at detectable concentrations in the clay samples, thus providing direct evidence that immobile forms predominate within the clay.

Based on available information, it is likely that the selenium is naturally occurring within the clays and is immobilized due to natural processes. In addition, an assessment of the factors involved in calculating the cleanup goal for site sediments indicates that the process appears to be overly conservative, and there is reasonable support to conclude that leaving the clays underlying the excavated sediments in place would not result in any adverse impact to ecological receptors.

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TABLES

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TABLE 3-1

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-130	Selenium	0.88		0.7	mg/kg	07/19/06
04-132	Selenium	0.7	U	0.7	mg/kg	07/19/06
04-134	Selenium	0.7	U	0.7	mg/kg	07/19/06
04-136	Selenium	0.6	U	0.6	mg/kg	07/19/06
04-138	Selenium	0.7	U	0.7	mg/kg	07/19/06
04-140	Selenium	0.6	UJ	0.6	mg/kg	07/19/06
04-142	Selenium	0.7	UJ	0.7	mg/kg	07/19/06
04-144	Selenium	0.94	J	0.6	mg/kg	07/19/06
04-146	Selenium	0.63	J	0.6	mg/kg	07/19/06
04-148	Selenium	0.31	J	0.6	mg/kg	08/22/06
04-150	Selenium	0.57	J	0.6	mg/kg	08/22/06
04-152	Selenium	1.4	J	0.6	mg/kg	08/22/06
04-155	Selenium	1.4	J	0.6	mg/kg	08/22/06
04-158	Selenium	0.7	U	0.7	mg/kg	08/22/06
04-161	Selenium	0.62	J	0.7	mg/kg	08/22/06
04-164	Selenium	0.6	UJ	0.6	mg/kg	08/22/06
04-167	Selenium	0.57	J	0.7	mg/kg	08/22/06
04-169	Selenium	0.7	U	0.7	mg/kg	08/22/06
04-170	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-171	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-172	Selenium	0.7	U	0.7	mg/kg	08/22/06
04-173	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-174	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-175	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-176	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-177	Selenium	0.38	J	0.6	mg/kg	08/22/06
04-178	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-179	Selenium	0.6	U	0.6	mg/kg	08/22/06
04-180	Selenium	0.8	U	0.8	mg/kg	08/22/06
04-181	Selenium	0.44	J	0.7	mg/kg	08/22/06
04-182	Selenium	0.7	U	0.7	mg/kg	08/22/06
04-183	Selenium	0.4	J	0.6	mg/kg	08/31/06
04-184	Selenium	0.6	U	0.6	mg/kg	08/31/06
04-185	Selenium	1.1		1	mg/kg	08/31/06
04-186	Selenium	0.6	U	0.6	mg/kg	08/31/06
04-187	Selenium	1.5		0.9	mg/kg	08/31/06
04-188	Selenium	1.1		0.8	mg/kg	08/31/06
04-189	Selenium	1.3		0.7	mg/kg	08/31/06
04-190	Selenium	0.49	J	0.7	mg/kg	08/31/06
04-191	Selenium	0.93		0.7	mg/kg	08/31/06
04-192	Selenium	0.73		0.7	mg/kg	08/31/06
04-193	Selenium	1.3		0.7	mg/kg	08/31/06
04-194	Selenium	1.6		0.6	mg/kg	08/31/06
04-195	Selenium	1.3		0.6	mg/kg	08/31/06
04-196	Selenium	1		0.6	mg/kg	08/31/06
04-197	Selenium	1.8		0.6	mg/kg	08/31/06
04-198	Selenium	2.3	J	0.6	mg/kg	09/26/06

TABLE 3-1

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-199	Selenium	2	J	0.6	mg/kg	09/26/06
04-200	Selenium	0.67	J	0.9	mg/kg	09/26/06
04-201	Selenium	0.7	U	0.7	mg/kg	09/26/06
04-202	Selenium	0.6	U	0.6	mg/kg	09/26/06
04-222	Selenium	0.6	U	0.6	mg/kg	09/26/06
04-223	Selenium	0.78		0.6	mg/kg	09/26/06
04-224	Selenium	0.6	U	0.6	mg/kg	09/26/06
04-225	Selenium	0.48	J	0.6	mg/kg	09/26/06
04-226	Selenium	0.4	J	0.6	mg/kg	09/26/06
04-227	Selenium	0.7	U	0.7	mg/kg	09/26/06
04-228	Selenium	0.6	UJ	0.6	mg/kg	09/26/06
04-229	Selenium	0.7	UJ	0.7	mg/kg	09/26/06
04-230	Selenium	0.6	U	0.6	mg/kg	09/26/06
04-231	Selenium	0.6	U	0.6	mg/kg	09/26/06
04-232	Selenium	2		0.6	mg/kg	09/26/06
04-233	Selenium	2.6		0.6	mg/kg	09/26/06
04-234	Selenium	0.7	U	0.7	mg/kg	09/26/06
04-235	Selenium	0.7	U	0.7	mg/kg	09/26/06
04-241	Selenium	0.6	U	0.6	mg/kg	10/03/06
04-242	Selenium	0.8	U	0.8	mg/kg	10/03/06
04-243	Selenium	0.6	U	0.6	mg/kg	10/03/06
04-244	Selenium	0.6	U	0.6	mg/kg	10/19/06
04-245	Selenium	0.7	U	0.7	mg/kg	10/25/06
04-246	Selenium	0.6	U	0.6	mg/kg	10/25/06
04-247	Selenium	0.6	U	0.6	mg/kg	10/25/06
04-248	Selenium	0.54	J	0.6	mg/kg	10/25/06
04-249	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-250	Selenium	0.6	U	0.6	mg/kg	10/25/06
04-251	Selenium	0.81		0.6	mg/kg	10/25/06
04-252	Selenium	0.74		0.6	mg/kg	10/25/06
04-253	Selenium	0.52	J	0.6	mg/kg	10/25/06
04-254	Selenium	1.5		0.6	mg/kg	10/25/06
04-255	Selenium	0.6	U	0.6	mg/kg	10/25/06
04-256	Selenium	0.6	U	0.6	mg/kg	10/25/06
04-257	Selenium	0.58	J	0.6	mg/kg	10/25/06
04-258	Selenium	0.5	J	0.6	mg/kg	10/25/06
04-259	Selenium	0.7	UJ	0.7	mg/kg	10/25/06
04-260	Selenium	2.1		0.6	mg/kg	10/25/06
04-261	Selenium	2.4		0.6	mg/kg	10/25/06
04-262	Selenium	0.6	U	0.6	mg/kg	10/25/06
04-268	Selenium	0.46	J	0.6	mg/kg	10/25/06
04-269	Selenium	0.7	U	0.7	mg/kg	10/25/06
04-270	Selenium	1.4		0.6	mg/kg	10/25/06
04-271	Selenium	1.3	J	0.7	mg/kg	10/25/06
04-272	Selenium	1	UJ	1	mg/kg	10/25/06
04-273	Selenium	2.2	J	0.7	mg/kg	10/25/06
04-274	Selenium	3.1	J	0.6	mg/kg	10/25/06

TABLE 3-1

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-275	Selenium	1.7	J	0.6	mg/kg	10/25/06
04-276	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-277	Selenium	2.9	J	0.7	mg/kg	10/25/06
04-278	Selenium	1.1	J	0.6	mg/kg	10/25/06
04-279	Selenium	0.97	J	0.7	mg/kg	10/25/06
04-280	Selenium	0.98	J	0.7	mg/kg	10/25/06
04-281	Selenium	0.42	J	0.6	mg/kg	10/25/06
04-282	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-283	Selenium	2.6	J	0.6	mg/kg	10/25/06
04-284	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-285	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-286	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-287	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-288	Selenium	0.6	UJ	0.6	mg/kg	10/25/06
04-291	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-292	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-293	Selenium	0.66	J	0.6	mg/kg	10/26/06
04-294	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-295	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-296	Selenium	0.7	U	0.7	mg/kg	10/26/06
04-297	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-298	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-299	Selenium	0.7	U	0.7	mg/kg	10/26/06
04-300	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-301	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-302	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-303	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-304	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-305	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-306	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-307	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-308	Selenium	1.3	J	0.7	mg/kg	10/26/06
04-309	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-310	Selenium	0.7	U	0.7	mg/kg	10/26/06
04-311	Selenium	0.7	U	0.7	mg/kg	10/26/06
04-312	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-313	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-314	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-315	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-316	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-317	Selenium	0.7	U	0.7	mg/kg	10/26/06
04-318	Selenium	0.95	J	0.6	mg/kg	10/26/06
04-319	Selenium	1.8	J	0.6	mg/kg	10/26/06
04-320	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-321	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-322	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-323	Selenium	0.7	U	0.7	mg/kg	10/26/06

TABLE 3-1

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-324	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-325	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-326	Selenium	0.6	UJ	0.6	mg/kg	10/26/06
04-327	Selenium	0.6	UJ	0.6	mg/kg	10/26/06
04-328	Selenium	0.6	U	0.6	mg/kg	10/26/06
04-329	Selenium	0.67	J	0.6	mg/kg	10/26/06
04-330	Selenium	0.6	UJ	0.6	mg/kg	10/26/06
04-331	Selenium	0.6	UJ	0.6	mg/kg	10/26/06
04-332	Selenium	0.7	UJ	0.7	mg/kg	10/26/06
04-333	Selenium	0.98	J	0.7	mg/kg	10/26/06
04-334	Selenium	0.6	UJ	0.6	mg/kg	10/26/06
04-335	Selenium	0.61	J	0.6	mg/kg	10/26/06
04-336	Selenium	0.7	UJ	0.7	mg/kg	10/26/06
04-337	Selenium	0.6	UJ	0.6	mg/kg	10/26/06
04-338	Selenium	1.5	J	0.6	mg/kg	10/26/06
04-339	Selenium	1.4	J	0.6	mg/kg	10/26/06
04-340	Selenium	1.3	J	0.6	mg/kg	10/26/06
04-341	Selenium	0.7	UJ	0.7	mg/kg	10/27/06
04-342	Selenium	0.91	J	0.7	mg/kg	10/27/06
04-343	Selenium	0.7	UJ	0.7	mg/kg	10/27/06
04-344	Selenium	0.7	UJ	0.7	mg/kg	10/27/06
04-345	Selenium	1.8	J	0.6	mg/kg	10/27/06
04-346	Selenium	0.6	UJ	0.6	mg/kg	10/27/06
04-347	Selenium	1	J	0.6	mg/kg	10/27/06
04-348	Selenium	0.6	U	0.6	mg/kg	10/27/06
04-349	Selenium	1.5		0.6	mg/kg	10/27/06
04-350	Selenium	1.2	J	0.7	mg/kg	10/27/06
04-351	Selenium	0.6	UJ	0.6	mg/kg	10/27/06
04-352	Selenium	2.3	J	0.6	mg/kg	10/27/06
04-353	Selenium	0.72	J	0.7	mg/kg	10/27/06
04-354	Selenium	1.6	J	0.7	mg/kg	10/27/06
04-355	Selenium	0.7	UJ	0.7	mg/kg	10/27/06
04-356	Selenium	3.7	J	0.7	mg/kg	10/27/06
04-357	Selenium	1.4	J	0.7	mg/kg	10/27/06
04-358	Selenium	4.3		0.6	mg/kg	10/27/06
04-359	Selenium	1.3		0.6	mg/kg	10/27/06
04-360	Selenium	1.1	J	0.6	mg/kg	10/27/06
04-361	Selenium	2.2	J	0.7	mg/kg	10/27/06
04-362	Selenium	3.9	J	0.6	mg/kg	10/27/06
04-363	Selenium	6.6	J	0.6	mg/kg	10/27/06
04-364	Selenium	1.7	J	0.7	mg/kg	10/27/06
04-365	Selenium	5.7	J	0.6	mg/kg	10/27/06
04-366	Selenium	2.9	J	0.6	mg/kg	10/27/06
04-367	Selenium	3.5	J	0.7	mg/kg	10/27/06
04-368	Selenium	6		0.7	mg/kg	10/27/06
04-369	Selenium	0.6	U	0.6	mg/kg	10/27/06
04-370	Selenium	7.2	J	0.6	mg/kg	10/27/06

TABLE 3-1

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-371	Selenium	4.6	J	0.7	mg/kg	10/27/06
04-372	Selenium	2.4	J	0.7	mg/kg	10/27/06
04-373	Selenium	2.5	J	0.6	mg/kg	10/27/06
04-374	Selenium	2.6	J	0.6	mg/kg	10/27/06
04-375	Selenium	0.7	UJ	0.7	mg/kg	10/27/06

Statistical Information [1]**:**

Mean:	1.08 mg/kg
Minimum Value:	0.31 mg/kg
Maximum Value:	7.2 mg/kg
95 percent UCL:	1.25 mg/kg

Notes:

[1]Statisical information calculated using Analyse-it version 1.71; reporting limit used when analyte not detected

Abbreviations and Acronyms:

J – the reported value is estimated
mg/kg – milligrams per kilogram
U – not detected above the reporting limit
UCL – upper confidence limit
Shading indicates value above cleanup goal of 0.926 mg/kg

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TABLE 3-2

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN MARRIAGE ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-001	Selenium	0.36	J	0.6	mg/kg	06/01/06
04-002	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-003	Selenium	0.71		0.6	mg/kg	06/01/06
04-004	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-005	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-006	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-007	Selenium	1.7		0.7	mg/kg	06/01/06
04-008	Selenium	0.55	U	0.6	mg/kg	06/01/06
04-009	Selenium	0.86	J	0.6	mg/kg	06/01/06
04-010	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-011	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-012	Selenium	0.53	J	0.6	mg/kg	06/01/06
04-013	Selenium	0.96		0.6	mg/kg	06/01/06
04-014	Selenium	0.53	J	0.6	mg/kg	06/01/06
04-015	Selenium	0.6		0.6	mg/kg	06/01/06
04-016	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-017	Selenium	0.7		0.6	mg/kg	06/01/06
04-018	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-019	Selenium	0.98	J	0.6	mg/kg	06/01/06
04-020	Selenium	0.33	J	0.7	mg/kg	06/01/06
04-021	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-022	Selenium	0.32	J	0.6	mg/kg	06/01/06
04-023	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-024	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-025	Selenium	0.6	UJ	0.6	mg/kg	06/01/06
04-026	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-027	Selenium	0.6	UJ	0.6	mg/kg	06/01/06
04-028	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-029	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-030	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-031	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-032	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-033	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-034	Selenium	0.7	U	0.7	mg/kg	06/01/06
04-035	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-036	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-037	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-038	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-039	Selenium	0.6	U	0.6	mg/kg	06/01/06
04-040	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-041	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-042	Selenium	0.7	UJ	0.7	mg/kg	06/01/06
04-043	Selenium	0.8	UJ	0.8	mg/kg	06/01/06

TABLE 3-2

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN MARRIAGE ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-044	Selenium	0.46	J	0.7	mg/kg	06/01/06
04-045	Selenium	0.7	UJ	0.7	mg/kg	06/01/06

Statistical Information [1] :

Mean:	0.68 mg/kg
Minimum Value:	0.32 mg/kg
Maximum Value:	1.7 mg/kg
95 percent UCL:	Not Applicable

Notes:

[1]Statisical information calculated using Analyse-it version 1.71; reporting limit used when analyte not detected

Abbreviations and Acronyms:

J – the reported value is estimated
mg/kg – milligrams per kilogram
U – not detected above the reporting limit
UCL – upper confidence limit
Shading indicates value above cleanup goal of 0.926 mg/kg

TABLE 3-3

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN NORTH PATROL ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-046	Selenium	0.8	U	0.8	mg/kg	06/01/06
04-047	Selenium	0.8	U	0.8	mg/kg	06/01/06
04-048	Selenium	0.53	J	0.7	mg/kg	06/06/06
04-049	Selenium	1.7	J	0.9	mg/kg	06/06/06
04-050	Selenium	1.4		0.8	mg/kg	06/06/06
04-051	Selenium	1.4		0.8	mg/kg	06/06/06
04-052	Selenium	0.36	J	0.7	mg/kg	06/06/06
04-053	Selenium	0.94		0.7	mg/kg	06/06/06
04-054	Selenium	0.46	J	0.7	mg/kg	06/06/06
04-055	Selenium	0.7	U	0.7	mg/kg	06/06/06
04-056	Selenium	0.35	J	0.7	mg/kg	06/06/06
04-057	Selenium	0.7	U	0.7	mg/kg	06/06/06
04-058	Selenium	1.1	J	0.7	mg/kg	06/06/06
04-059	Selenium	0.7	UJ	0.7	mg/kg	06/06/06
04-060	Selenium	0.7	U	0.7	mg/kg	06/06/06
04-061	Selenium	0.55	J	0.7	mg/kg	06/06/06
04-062	Selenium	1.1		0.7	mg/kg	06/06/06
04-063	Selenium	1.2		0.8	mg/kg	06/06/06
04-064	Selenium	1.6		0.7	mg/kg	06/06/06
04-065	Selenium	0.78		0.7	mg/kg	06/06/06
04-066	Selenium	0.66	J	0.7	mg/kg	06/06/06
04-067	Selenium	1.3		0.8	mg/kg	06/06/06
04-068	Selenium	1.2	J	0.9	mg/kg	06/06/06
04-069	Selenium	1.3	J	0.7	mg/kg	06/06/06
04-070	Selenium	1.4		0.8	mg/kg	06/06/06
04-071	Selenium	1		0.7	mg/kg	06/06/06
04-072	Selenium	1.3		0.7	mg/kg	06/06/06
04-073	Selenium	0.95		0.7	mg/kg	06/06/06
04-074	Selenium	0.98		0.7	mg/kg	06/06/06
04-075	Selenium	1.4		0.7	mg/kg	06/06/06
04-076	Selenium	1		0.7	mg/kg	06/06/06
04-077	Selenium	1.6		0.7	mg/kg	06/06/06
04-078	Selenium	1.7	J	0.7	mg/kg	06/06/06
04-079	Selenium	1.5	J	0.7	mg/kg	06/06/06
04-080	Selenium	6.3		0.7	mg/kg	06/14/06
04-081	Selenium	5.7		0.7	mg/kg	06/14/06
04-082	Selenium	5.9		0.7	mg/kg	06/14/06
04-083	Selenium	3.6		0.7	mg/kg	06/14/06
04-084	Selenium	3		0.6	mg/kg	06/14/06
04-085	Selenium	1.5		0.6	mg/kg	06/14/06
04-086	Selenium	1.6		0.6	mg/kg	06/14/06
04-087	Selenium	2.3		0.7	mg/kg	06/14/06
04-088	Selenium	0.7	UJ	0.7	mg/kg	06/14/06
04-089	Selenium	0.7	UJ	0.7	mg/kg	06/14/06
04-090	Selenium	2		0.6	mg/kg	06/14/06
04-091	Selenium	3.4		0.8	mg/kg	06/14/06
04-092	Selenium	4.3		0.7	mg/kg	06/14/06

TABLE 3-3

SELENIUM CONCENTRATIONS IN CONFIRMATION SAMPLES FROM CLAY IN NORTH PATROL ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
04-093	Selenium	2.7		0.7	mg/kg	06/14/06
04-094	Selenium	2.5		0.6	mg/kg	06/14/06
04-095	Selenium	2.4		0.7	mg/kg	06/14/06
04-096	Selenium	2.3		0.6	mg/kg	06/14/06
04-097	Selenium	1.4	J	0.6	mg/kg	06/14/06
04-098	Selenium	0.54	J	0.7	mg/kg	06/14/06
04-099	Selenium	0.7	UJ	0.7	mg/kg	06/14/06
04-100	Selenium	0.95	J	0.6	mg/kg	06/14/06
04-101	Selenium	0.75	J	0.6	mg/kg	06/14/06
04-102	Selenium	0.72	J	0.6	mg/kg	06/14/06
04-103	Selenium	0.54	J	0.6	mg/kg	06/14/06
04-104	Selenium	0.48	J	0.6	mg/kg	06/15/06
04-105	Selenium	1.1	J	0.6	mg/kg	06/15/06
04-106	Selenium	1.1	J	0.6	mg/kg	06/15/06
04-107	Selenium	0.95		0.6	mg/kg	06/15/06
04-108	Selenium	0.6	UJ	0.6	mg/kg	06/15/06
04-109	Selenium	0.7	UJ	0.7	mg/kg	06/15/06
04-110	Selenium	0.81	J	0.6	mg/kg	06/15/06
04-111	Selenium	1.3	J	0.7	mg/kg	06/15/06
04-112	Selenium	0.93	J	0.6	mg/kg	06/15/06
04-113	Selenium	1.6	J	0.7	mg/kg	06/15/06
04-114	Selenium	0.99	J	0.7	mg/kg	06/15/06
04-115	Selenium	0.56	J	0.6	mg/kg	06/15/06
04-116	Selenium	0.6	UJ	0.6	mg/kg	06/15/06
04-117	Selenium	0.7	UJ	0.7	mg/kg	06/15/06
04-118	Selenium	0.7	UJ	0.7	mg/kg	06/15/06
04-119	Selenium	0.6	UJ	0.6	mg/kg	06/15/06
04-120	Selenium	0.6	UJ	0.6	mg/kg	06/15/06
04-121	Selenium	0.6	UJ	0.6	mg/kg	06/15/06
04-122	Selenium	0.39	J	0.7	mg/kg	06/15/06
04-123	Selenium	0.39	J	0.6	mg/kg	06/15/06
04-124	Selenium	1	J	0.7	mg/kg	06/15/06
04-125	Selenium	0.49	J	0.6	mg/kg	06/15/06

Statistical Information* [1] *:

Mean:	1.36 mg/kg
Minimum Value:	0.35 mg/kg
Maximum Value:	6.3 mg/kg
95 percent UCL:	1.89 mg/kg

Notes:

Statisical information calculated using Analyse-it version 1.71; reporting limit used when analyte not detected

Abbreviations and Acronyms:

J – the reported value is estimated
mg/kg – milligrams per kilogram
U – not detected above the reporting limit
UCL – upper confidence limit
Shading indicates value above cleanup goal of 0.926 mg/kg

TABLE 3-4

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0212	Selenium	9.4		2	mg/kg	2/9/06
98-0213	Selenium	12.6		1.9	mg/kg	2/9/06
98-0214	Selenium	16.4		1.5	mg/kg	2/9/06
98-0215	Selenium	4.7		2	mg/kg	2/9/06
98-0216	Selenium	7.8		1	mg/kg	2/9/06
98-0217	Selenium	10.5		1.1	mg/kg	2/9/06
98-0218	Selenium	18.7		1.4	mg/kg	2/9/06
98-0219	Selenium	10.5		1.1	mg/kg	2/9/06
98-0220	Selenium	9.9		1.2	mg/kg	2/9/06
98-0221	Selenium	8.4		1.2	mg/kg	2/9/06
98-0222	Selenium	9		1.1	mg/kg	2/9/06
98-0223	Selenium	7.8		1.3	mg/kg	2/9/06
98-0224	Selenium	8.5		1.1	mg/kg	2/9/06
98-0225	Selenium	10.1		1.2	mg/kg	2/9/06
98-0226	Selenium	7.1		1.2	mg/kg	2/10/06
98-0227	Selenium	6.4		1.3	mg/kg	2/10/06
98-0228	Selenium	5.8		1.2	mg/kg	2/10/06
98-0229	Selenium	4.7		1.2	mg/kg	2/10/06
98-0230	Selenium	4.1		1	mg/kg	2/10/06
98-0231	Selenium	2.6		1	mg/kg	2/10/06
98-0232	Selenium	3.1		0.9	mg/kg	2/10/06
98-0233	Selenium	1.4		0.8	mg/kg	2/10/06
98-0234	Selenium	4.4		1.1	mg/kg	2/10/06
98-0235	Selenium	2.7		1.1	mg/kg	2/10/06
98-0236	Selenium	1.5		1	mg/kg	2/10/06
98-0237	Selenium	1.9		0.9	mg/kg	2/10/06
98-0238	Selenium	2.3		1.1	mg/kg	2/10/06
98-0239	Selenium	2.7		1.4	mg/kg	2/10/06
98-0240	Selenium	4.1		1	mg/kg	2/10/06
98-0241	Selenium	3.4		1	mg/kg	2/10/06
98-0242	Selenium	4.6		1.1	mg/kg	2/10/06
98-0243	Selenium	2.8		0.9	mg/kg	2/10/06
98-0244	Selenium	7.3		1.2	mg/kg	2/10/06
98-0245	Selenium	3.7		1.1	mg/kg	2/10/06
98-0246	Selenium	5.2		1.1	mg/kg	2/10/06
98-0247	Selenium	4.6		1.2	mg/kg	2/10/06
98-0248	Selenium	9.1		1.3	mg/kg	2/10/06
98-0249	Selenium	11.5		1.4	mg/kg	2/10/06
98-0250	Selenium	10.8		1.3	mg/kg	2/10/06
98-0251	Selenium	8.4		1.4	mg/kg	2/10/06
98-0252	Selenium	11.2		1.2	mg/kg	2/10/06
98-0253	Selenium	3.1		1.1	mg/kg	2/13/06
98-0254	Selenium	5		1.2	mg/kg	2/13/06
98-0255	Selenium	4.6		1.3	mg/kg	2/13/06
98-0256	Selenium	1.8		1	mg/kg	2/13/06
98-0257	Selenium	2.5		1.1	mg/kg	2/13/06
98-0258	Selenium	3.8		1.3	mg/kg	2/13/06

TABLE 3-4

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0259	Selenium	1.7		1.3	mg/kg	2/13/06
98-0260	Selenium	3.9		2.2	mg/kg	2/13/06
98-0261	Selenium	4		1.3	mg/kg	2/13/06
98-0262	Selenium	7.5		1.3	mg/kg	2/13/06
98-0263	Selenium	1.3		1.1	mg/kg	2/13/06
98-0264	Selenium	7		1.4	mg/kg	2/13/06
98-0265	Selenium	3.8		1.1	mg/kg	2/13/06
98-0266	Selenium	4.5		1.2	mg/kg	2/13/06
98-0267	Selenium	2.9		1.5	mg/kg	2/13/06
98-0268	Selenium	1	J	1.2	mg/kg	2/13/06
98-0269	Selenium	1.2	U	1.2	mg/kg	2/13/06
98-0270	Selenium	1.5	U	1.5	mg/kg	2/13/06
98-0271	Selenium	8.4		1.3	mg/kg	2/13/06
98-0272	Selenium	1.8		1.4	mg/kg	2/13/06
98-0273	Selenium	2.9		1.1	mg/kg	2/13/06
98-0274	Selenium	2.9		1	mg/kg	2/13/06
98-0275	Selenium	0.87	J	1.1	mg/kg	2/13/06
98-0276	Selenium	4.5		1.3	mg/kg	2/13/06
98-0277	Selenium	0.84	J	1.1	mg/kg	2/13/06
98-0278	Selenium	2.9		0.9	mg/kg	2/13/06
98-0279	Selenium	1.9		0.9	mg/kg	2/13/06
98-0280	Selenium	1.1	U	1.1	mg/kg	2/13/06
98-0281	Selenium	1.5		1.1	mg/kg	2/13/06
98-0282	Selenium	1.5		0.9	mg/kg	2/13/06
98-0283	Selenium	8.6		1.9	mg/kg	2/14/06
98-0284	Selenium	5.4		1.3	mg/kg	2/14/06
98-0285	Selenium	3.4		1.1	mg/kg	2/14/06
98-0286	Selenium	7.8		1.3	mg/kg	2/14/06
98-0287	Selenium	3.8		1.3	mg/kg	2/14/06
98-0288	Selenium	4.3		1.4	mg/kg	2/14/06
98-0289	Selenium	2.6		0.9	mg/kg	2/14/06
98-0290	Selenium	5.6		1.1	mg/kg	2/14/06
98-0291	Selenium	3.2		0.9	mg/kg	2/14/06
98-0292	Selenium	6.9		1.2	mg/kg	2/14/06
98-0293	Selenium	4.4		1.5	mg/kg	2/14/06
98-0294	Selenium	2.6		0.9	mg/kg	2/14/06
98-0295	Selenium	2.7		1	mg/kg	2/14/06
98-0296	Selenium	4.8		1	mg/kg	2/14/06
98-0297	Selenium	5.3		1.3	mg/kg	2/14/06
98-0298	Selenium	3.7		1	mg/kg	2/14/06
98-0299	Selenium	3.3		1	mg/kg	2/14/06
98-0300	Selenium	2.2		0.9	mg/kg	2/14/06
98-0301	Selenium	6.3		1.1	mg/kg	2/14/06
98-0302	Selenium	5.2		1.2	mg/kg	2/14/06
98-0303	Selenium	3.4		0.9	mg/kg	2/14/06
98-0304	Selenium	7		1.3	mg/kg	2/14/06
98-0305	Selenium	3.4		1	mg/kg	2/14/06

TABLE 3-4

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0306	Selenium	2.9		0.9	mg/kg	2/14/06
98-0307	Selenium	2.8		0.9	mg/kg	2/14/06
98-0308	Selenium	6.3		1.2	mg/kg	2/14/06
98-0309	Selenium	3.2		1.1	mg/kg	2/14/06
98-0310	Selenium	4.5		1	mg/kg	2/14/06
98-0311	Selenium	2.8		0.9	mg/kg	2/14/06
98-0312	Selenium	3.9		1	mg/kg	2/14/06
98-0313	Selenium	4.3		0.9	mg/kg	2/14/06
98-0314	Selenium	3		0.9	mg/kg	2/14/06
98-0315	Selenium	4.6		1	mg/kg	2/14/06
98-0316	Selenium	2.3		1	mg/kg	2/14/06
98-0317	Selenium	2		0.9	mg/kg	2/14/06
98-0318	Selenium	3.6		1	mg/kg	2/14/06
98-0319	Selenium	3.3		1	mg/kg	2/14/06
98-0320	Selenium	3.2		1.1	mg/kg	2/14/06
98-0321	Selenium	4.2		1.2	mg/kg	2/14/06
98-0322	Selenium	3.9		1.1	mg/kg	2/14/06
98-0323	Selenium	2.8		1	mg/kg	2/15/06
98-0324	Selenium	2.9		1	mg/kg	2/15/06
98-0325	Selenium	4.9		1.1	mg/kg	2/15/06
98-0326	Selenium	4.4		1.2	mg/kg	2/15/06
98-0327	Selenium	3.1		1	mg/kg	2/15/06
98-0328	Selenium	5.1		1.1	mg/kg	2/15/06
98-0329	Selenium	5.4		1.1	mg/kg	2/15/06
98-0330	Selenium	2.5		0.9	mg/kg	2/15/06
98-0331	Selenium	3.3		1.2	mg/kg	2/15/06
98-0332	Selenium	4		1.2	mg/kg	2/15/06
98-0333	Selenium	4.3		1.1	mg/kg	2/15/06
98-0334	Selenium	4.6		1.1	mg/kg	2/15/06
98-0335	Selenium	5.9		1.1	mg/kg	2/15/06
98-0336	Selenium	4		1.2	mg/kg	2/15/06
98-0337	Selenium	3.2		0.9	mg/kg	2/15/06
98-0338	Selenium	4.8		1	mg/kg	2/15/06
98-0339	Selenium	3.4		1.1	mg/kg	2/15/06
98-0340	Selenium	3.5		1	mg/kg	2/15/06
98-0341	Selenium	3		1	mg/kg	2/15/06
98-0342	Selenium	4.2		1	mg/kg	2/15/06
98-0343	Selenium	1.6		0.8	mg/kg	2/15/06
98-0344	Selenium	4.1		1.3	mg/kg	2/15/06
98-0345	Selenium	2.2		1.1	mg/kg	2/15/06
98-0346	Selenium	4.3		0.9	mg/kg	2/15/06
98-0347	Selenium	2.9		1	mg/kg	2/15/06
98-0348	Selenium	1.3		0.9	mg/kg	2/15/06
98-0349	Selenium	2.9		1	mg/kg	2/15/06
98-0350	Selenium	2.4		0.9	mg/kg	2/15/06
98-0351	Selenium	1.6		0.8	mg/kg	2/15/06
98-0352	Selenium	4		1.1	mg/kg	2/15/06

TABLE 3-4

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0353	Selenium	1.7		1	mg/kg	2/15/06
98-0354	Selenium	4.4		1.1	mg/kg	2/15/06
98-0355	Selenium	2.8		1	mg/kg	2/15/06
98-0356	Selenium	3.6		1.2	mg/kg	2/15/06
98-0357	Selenium	3.5		1.2	mg/kg	2/16/06
98-0358	Selenium	5.9		1.1	mg/kg	2/16/06
98-0359	Selenium	3.3		1.2	mg/kg	2/16/06
98-0360	Selenium	2.6		1	mg/kg	2/16/06
98-0361	Selenium	3.7		1.2	mg/kg	2/16/06
98-0362	Selenium	4.1		1.2	mg/kg	2/16/06
98-0363	Selenium	4.5		0.9	mg/kg	2/16/06
98-0364	Selenium	13.2		0.8	mg/kg	2/16/06
98-0365	Selenium	12.3		1.5	mg/kg	2/16/06
98-0366	Selenium	10.4		1.1	mg/kg	2/16/06
98-0367	Selenium	11.7		1.3	mg/kg	2/16/06
98-0368	Selenium	9.8		1.4	mg/kg	2/16/06
98-0369	Selenium	11		1.5	mg/kg	2/16/06
98-0370	Selenium	9.5		1.4	mg/kg	2/16/06
98-0371	Selenium	11.2		1.6	mg/kg	2/16/06
98-0372	Selenium	13.9		1.7	mg/kg	2/16/06
98-0373	Selenium	10.5		1.6	mg/kg	2/16/06
98-0374	Selenium	11.5		1.6	mg/kg	2/16/06
98-0375	Selenium	7.2		1	mg/kg	2/16/06
98-0376	Selenium	7.8		1.1	mg/kg	2/16/06
98-0377	Selenium	9		1.3	mg/kg	2/16/06
98-0378	Selenium	7.2		1.2	mg/kg	2/16/06
98-0379	Selenium	7.3		1	mg/kg	2/16/06
98-0380	Selenium	8.8		1.2	mg/kg	2/16/06
98-0381	Selenium	6.4		1.1	mg/kg	2/16/06
98-0382	Selenium	6.5		1	mg/kg	2/16/06
98-0383	Selenium	8.4		1.1	mg/kg	2/16/06
98-0384	Selenium	5.9		1	mg/kg	2/16/06
98-0385	Selenium	8.1		1.1	mg/kg	2/16/06
98-0386	Selenium	8		1.1	mg/kg	2/16/06
98-0387	Selenium	7.9		1.1	mg/kg	2/16/06
98-0388	Selenium	10.3		1.3	mg/kg	2/16/06
98-0389	Selenium	12.1		1.3	mg/kg	2/16/06
98-0390	Selenium	9.5		1.1	mg/kg	2/16/06
98-0391	Selenium	10.7		1.3	mg/kg	2/16/06
98-0392	Selenium	8.2		1.2	mg/kg	2/16/06
98-0393	Selenium	12.9		1.3	mg/kg	2/16/06
98-0394	Selenium	9.5		1.2	mg/kg	2/16/06
98-0395	Selenium	10.3		1.1	mg/kg	2/16/06
98-0396	Selenium	11.1		1.1	mg/kg	2/16/06
98-0397	Selenium	10.4		1.1	mg/kg	2/16/06
98-0398	Selenium	11.5		1.3	mg/kg	2/17/06
98-0399	Selenium	10		1.3	mg/kg	2/17/06

TABLE 3-4

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTHERN CHANNEL

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0400	Selenium	11.9		1.3	mg/kg	2/17/06
98-0401	Selenium	6.5		1	mg/kg	2/17/06
98-0402	Selenium	11.8		1.3	mg/kg	2/17/06
98-0403	Selenium	4.4		1.2	mg/kg	2/17/06
98-0404	Selenium	9.2		1.3	mg/kg	2/17/06
98-0405	Selenium	9.8		1.3	mg/kg	2/17/06
98-0406	Selenium	4.5		0.8	mg/kg	2/17/06
98-0407	Selenium	7		1.1	mg/kg	2/17/06
98-0408	Selenium	8.7		1.2	mg/kg	2/17/06
98-0409	Selenium	9.3		1.2	mg/kg	2/17/06
98-0410	Selenium	7.1		1	mg/kg	2/17/06

Abbreviations and Acronyms:
J – the reported value is estimated
mg/kg – milligrams per kilogram
U – not detected above the reporting limit

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TABLE 3-5

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM MARRIAGE ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0018	Selenium	1.4		0.7	mg/kg	1/25/06
98-0019	Selenium	1.2		0.7	mg/kg	1/25/06
98-0020	Selenium	0.7	U	0.7	mg/kg	1/25/06
98-0021	Selenium	1.7		0.8	mg/kg	1/25/06
98-0022	Selenium	2.5		0.8	mg/kg	1/25/06
98-0023	Selenium	2		0.8	mg/kg	1/25/06
98-0024	Selenium	0.8	U	0.8	mg/kg	1/25/06
98-0025	Selenium	0.59	J	0.8	mg/kg	1/25/06
98-0026	Selenium	1.7		0.9	mg/kg	1/25/06
98-0027	Selenium	0.98		0.7	mg/kg	1/25/06
98-0028	Selenium	1.3		0.8	mg/kg	1/25/06
98-0029	Selenium	3.1		0.9	mg/kg	1/25/06
98-0030	Selenium	0.6	U	0.6	mg/kg	1/25/06
98-0031	Selenium	1.8		0.7	mg/kg	1/25/06
98-0032	Selenium	0.57	J	0.8	mg/kg	1/25/06
98-0033	Selenium	2.2		0.9	mg/kg	1/25/06
98-0034	Selenium	1.4		0.8	mg/kg	1/25/06
98-0035	Selenium	0.5	J	0.7	mg/kg	1/25/06
98-0036	Selenium	0.8	U	0.8	mg/kg	1/25/06
98-0037	Selenium	0.81		0.7	mg/kg	1/25/06
98-0038	Selenium	0.41	J	0.7	mg/kg	1/25/06
98-0039	Selenium	0.7	U	0.7	mg/kg	1/25/06
98-0040	Selenium	0.78		0.7	mg/kg	1/25/06
98-0041	Selenium	0.8	U	0.8	mg/kg	1/25/06
98-0059	Selenium	0.8	U	0.8	mg/kg	1/26/06
98-0060	Selenium	1.2		0.8	mg/kg	1/26/06
98-0061	Selenium	0.86		0.8	mg/kg	1/26/06
98-0062	Selenium	0.72	J	0.9	mg/kg	1/26/06
98-0063	Selenium	0.47	J	0.7	mg/kg	1/26/06
98-0064	Selenium	0.7	U	0.7	mg/kg	1/26/06
98-0065	Selenium	0.58	J	0.7	mg/kg	1/26/06
98-0066	Selenium	0.45	J	0.7	mg/kg	1/26/06
98-0067	Selenium	0.7	U	0.7	mg/kg	1/26/06
98-0068	Selenium	0.7	U	0.7	mg/kg	1/26/06
98-0069	Selenium	0.63	J	0.7	mg/kg	1/26/06
98-0070	Selenium	0.54	J	0.7	mg/kg	1/27/06
98-0071	Selenium	0.85		0.7	mg/kg	1/27/06
98-0072	Selenium	1	U	1	mg/kg	1/27/06
98-0073	Selenium	0.7	U	0.7	mg/kg	1/27/06

TABLE 3-5

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM MARRIAGE ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0074	Selenium	0.99		0.7	mg/kg	1/27/06
98-0075	Selenium	1.2		0.8	mg/kg	1/27/06
98-0076	Selenium	1		0.9	mg/kg	1/27/06
98-0077	Selenium	0.81	J	0.9	mg/kg	1/27/06
98-0078	Selenium	4		1.1	mg/kg	1/27/06
98-0079	Selenium	5.3		1.5	mg/kg	1/27/06
98-0080	Selenium	3.6		1.9	mg/kg	1/27/06

Abbreviations and Acronyms:
J – the reported value is estimated
mg/kg – milligrams per kilogram
U – not detected above the reporting limit

TABLE 3-6

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTH PATROL ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0127	Selenium	0.81		0.7	mg/kg	2/1/06
98-0128	Selenium	11.6		1.5	mg/kg	2/1/06
98-0129	Selenium	1.5		0.8	mg/kg	2/1/06
98-0130	Selenium	43		2.2	mg/kg	2/1/06
98-0131	Selenium	0.8	U	0.8	mg/kg	2/1/06
98-0132	Selenium	12.7		1.6	mg/kg	2/1/06
98-0133	Selenium	6.5		1.1	mg/kg	2/1/06
98-0134	Selenium	12.5		1.2	mg/kg	2/1/06
98-0135	Selenium	12.2		1.2	mg/kg	2/1/06
98-0136	Selenium	15.8		1.7	mg/kg	2/1/06
98-0137	Selenium	6.5		1.4	mg/kg	2/1/06
98-0138	Selenium	9.8		2.2	mg/kg	2/1/06
98-0139	Selenium	23.5		3.8	mg/kg	2/1/06
98-0140	Selenium	14.7		3.9	mg/kg	2/1/06
98-0141	Selenium	33.1		4.1	mg/kg	2/1/06
98-0142	Selenium	12.1		4.3	mg/kg	2/1/06
98-0143	Selenium	10.6		5.9	mg/kg	2/1/06
98-0144	Selenium	15.8		6.6	mg/kg	2/1/06
98-0145	Selenium	20.3		4.1	mg/kg	2/1/06
98-0146	Selenium	21.4		4.9	mg/kg	2/1/06
98-0147	Selenium	16		4	mg/kg	2/1/06
98-0148	Selenium	31.9		3.6	mg/kg	2/1/06
98-0149	Selenium	15.2		5.1	mg/kg	2/1/06
98-0150	Selenium	11.9		5	mg/kg	2/1/06
98-0151	Selenium	15.1		3	mg/kg	2/1/06
98-0152	Selenium	7.7		4.2	mg/kg	2/1/06
98-0153	Selenium	11.5		2.6	mg/kg	2/2/06
98-0154	Selenium	10.5		2.2	mg/kg	2/2/06
98-0155	Selenium	14.6		3	mg/kg	2/2/06
98-0156	Selenium	11.9		2.3	mg/kg	2/2/06
98-0157	Selenium	19.7		3.9	mg/kg	2/2/06
98-0158	Selenium	20.4		4.6	mg/kg	2/2/06
98-0159	Selenium	32.5		3.1	mg/kg	2/2/06
98-0160	Selenium	20.8		3.4	mg/kg	2/2/06
98-0161	Selenium	13.2		1.9	mg/kg	2/2/06
98-0162	Selenium	6.3		1.4	mg/kg	2/2/06
98-0163	Selenium	8.9		2.3	mg/kg	2/2/06
98-0164	Selenium	7.5		1.8	mg/kg	2/2/06
98-0165	Selenium	0.79	J	0.8	mg/kg	2/2/06
98-0166	Selenium	8.9		1.9	mg/kg	2/2/06
98-0167	Selenium	5.9		2	mg/kg	2/2/06
98-0168	Selenium	12.7		2	mg/kg	2/2/06
98-0169	Selenium	5		1.7	mg/kg	2/2/06
98-0170	Selenium	23		4.4	mg/kg	2/2/06
98-0171	Selenium	22		3.1	mg/kg	2/2/06

TABLE 3-6

SELENIUM CONCENTRATIONS IN WASTE CHARACTERIZATION SEDIMENT SAMPLES FROM THE NORTH PATROL ROAD DITCH

Sample Number	Analyte	Result	Qualifier	Reporting Limit	Units	Sample Date
98-0172	Selenium	20		4	mg/kg	2/2/06
98-0173	Selenium	16.4		3.3	mg/kg	2/2/06
98-0174	Selenium	12.4		2.4	mg/kg	2/2/06
98-0175	Selenium	19.1		3.7	mg/kg	2/2/06
98-0176	Selenium	10.2		2.4	mg/kg	2/6/06
98-0177	Selenium	10		2.4	mg/kg	2/6/06
98-0178	Selenium	17.2		4.3	mg/kg	2/6/06
98-0179	Selenium	7.8		2.6	mg/kg	2/6/06
98-0180	Selenium	7.7		1.8	mg/kg	2/6/06
98-0181	Selenium	12.7		2.5	mg/kg	2/6/06
98-0182	Selenium	12.6		2.2	mg/kg	2/6/06
98-0183	Selenium	15.1		2.3	mg/kg	2/6/06
98-0184	Selenium	12.2		2.1	mg/kg	2/6/06
98-0185	Selenium	11		2.1	mg/kg	2/6/06
98-0186	Selenium	12.2		2	mg/kg	2/6/06
98-0187	Selenium	14.1		2.6	mg/kg	2/6/06
98-0188	Selenium	11.7		2.1	mg/kg	2/6/06
98-0189	Selenium	13.9		2	mg/kg	2/6/06
98-0190	Selenium	19.9		3.2	mg/kg	2/6/06
98-0191	Selenium	13.5		1.7	mg/kg	2/6/06
98-0192	Selenium	10.4		2.1	mg/kg	2/6/06
98-0193	Selenium	15.7		2.6	mg/kg	2/6/06
98-0194	Selenium	18.7		3.3	mg/kg	2/6/06
98-0195	Selenium	14.1		3.2	mg/kg	2/6/06
98-0196	Selenium	19		3.5	mg/kg	2/7/06
98-0197	Selenium	14.5		2.6	mg/kg	2/7/06
98-0198	Selenium	14.9		2.8	mg/kg	2/7/06
98-0199	Selenium	21.2		3.6	mg/kg	2/7/06
98-0200	Selenium	7.6		2	mg/kg	2/7/06
98-0201	Selenium	13.3		2.6	mg/kg	2/7/06
98-0202	Selenium	14.3		2.9	mg/kg	2/7/06
98-0203	Selenium	17.1		2.9	mg/kg	2/7/06
98-0204	Selenium	19		3.1	mg/kg	2/7/06
98-0205	Selenium	13.5		2.4	mg/kg	2/7/06
98-0206	Selenium	18.6		4.4	mg/kg	2/7/06
98-0207	Selenium	14.8		3.1	mg/kg	2/7/06
98-0208	Selenium	10.7		2.1	mg/kg	2/7/06
98-0209	Selenium	11.8		2.4	mg/kg	2/7/06
98-0210	Selenium	8		1.8	mg/kg	2/7/06
98-0211	Selenium	11.1		2.3	mg/kg	2/7/06

Abbreviations and Acronyms:
J – the reported value is estimated
mg/kg – milligrams per kilogram
U – not detected above the reporting limit

FIGURES

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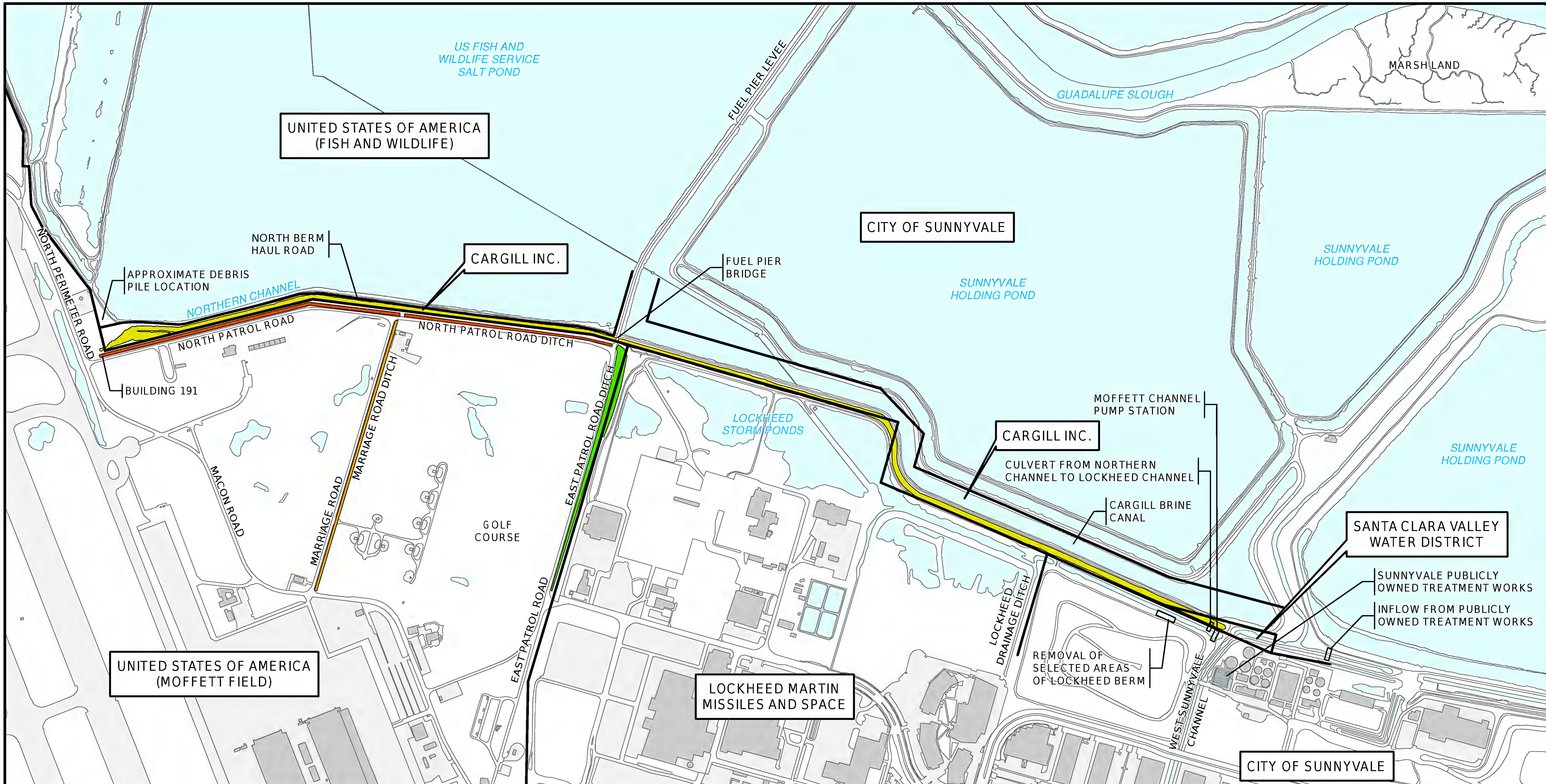


LEGEND

- NORTHERN CHANNEL EXCAVATION AREA
- NORTH PATROL ROAD DITCH EXCAVATION AREA
- MARRIAGE ROAD DITCH EXCAVATION AREA
- EAST PATROL ROAD DITCH
- SURVEYED PROPERTY BOUNDARIES
- ROAD
- PAVED SURFACE
- BUILDING
- WATER

SOURCE:

GOLDEN VALLEY ENGINEERING AND SURVEYING, PROPERTY BOUNDARY SURVEY, OCTOBER 2004.

N

400 0 400 800 Feet

Scale: 1" = 800'

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TECHNICAL MEMORANDUM FOR ASSESSING SELENIUM CONCENTRATIONS

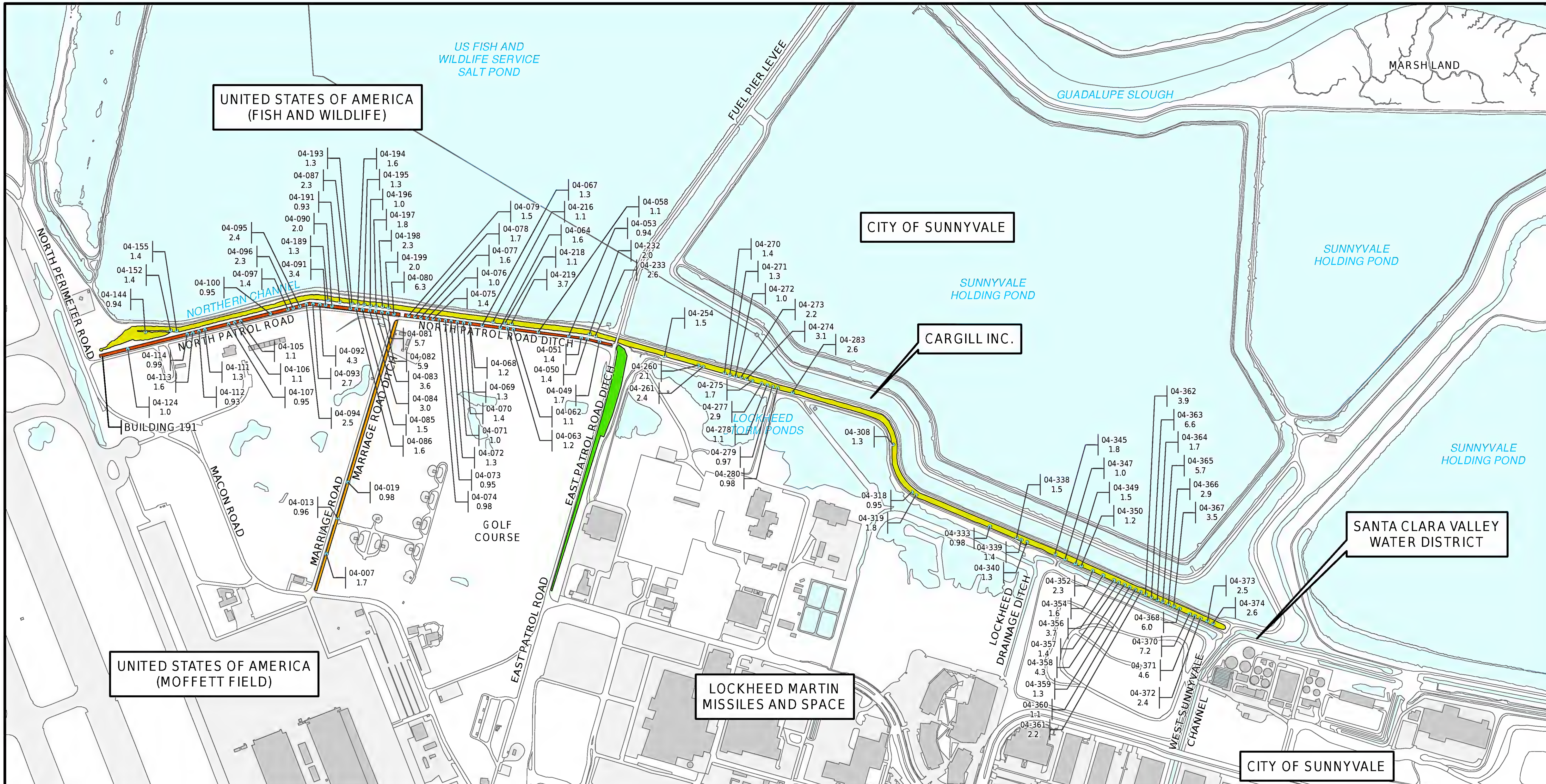
FIGURE 1-1

SITE LOCATION MAP

FORMER NAS MOFFETT FIELD, MOFFETT FIELD, CALIFORNIA

REVISION: 0
AUTHOR: GFG
DCN: ECSD-2201-0004-0002.R1
FILE NUMBER: 081238L3167.mxd

TETRA TECH EC, INC.



LEGEND

04-318 0.95 — CLAY SAMPLE NUMBER, CLAY CONCENTRATION RESULT (mg/kg)

NORTHERN CHANNEL EXCAVATION AREA

NORTH PATROL ROAD DITCH EXCAVATION AREA

MARRIAGE ROAD DITCH EXCAVATION AREA

EAST PATROL ROAD DITCH

ROAD

PAVED SURFACE

BUILDING

WATER

SOURCE:

GOLDEN VALLEY ENGINEERING AND SURVEYING, PROPERTY BOUNDARY SURVEY, OCTOBER 2004.

N

400 0 400 800 Feet

Scale: 1" = 800'

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

TECHNICAL MEMORANDUM FOR ASSESSING SELENIUM CONCENTRATIONS

FIGURE 3-1

CONFIRMATION SAMPLE CONCENTRATIONS IN CLAY THAT EXCEED THE CLEANUP GOAL OF 0.926 mg/kg

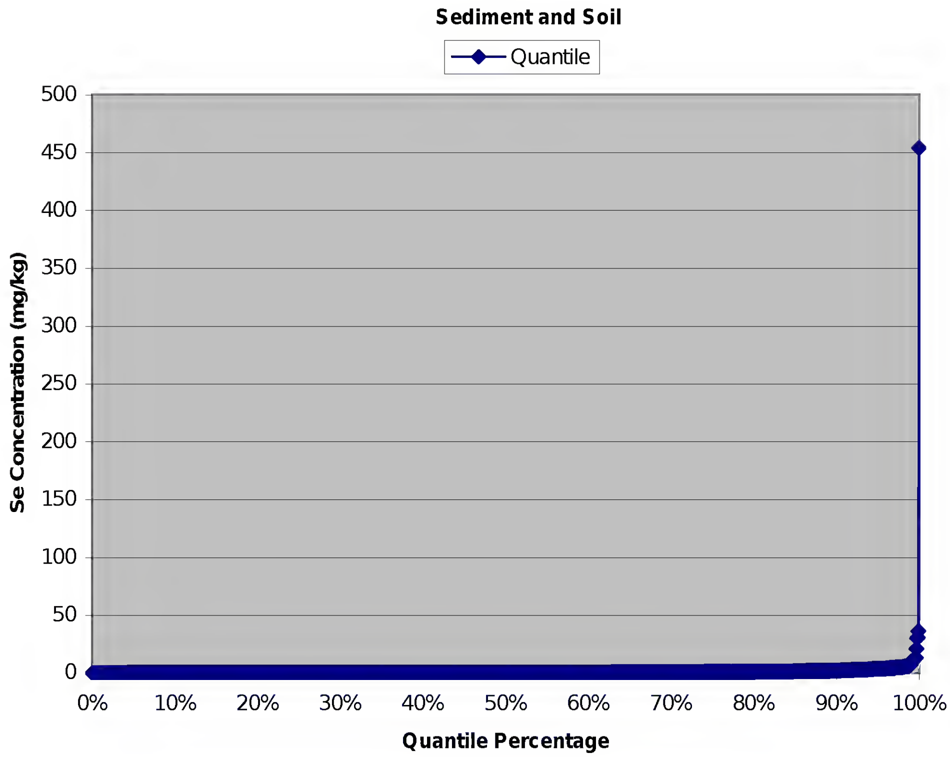
FORMER NAS MOFFETT FIELD, MOFFETT FIELD, CALIFORNIA

REVISION: 0
AUTHOR: GFG
DCN: ECSD-2201-0004-0002.R1
FILE NUMBER: 081238A3168.mxd

TETRA TECH EC, INC.

FIGURE 3-2

MULTIPLE FACTOR ANALYSIS QUANTILE PLOT SHOWING HISTORIC SELENIUM RESULTS FOR SEDIMENT AND SOIL



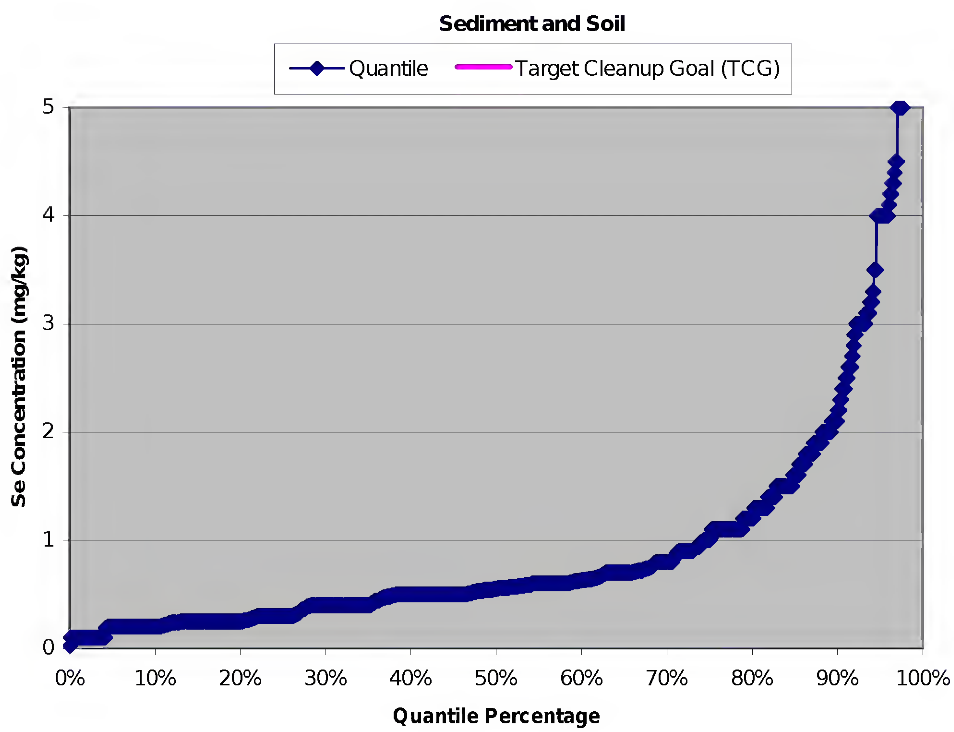
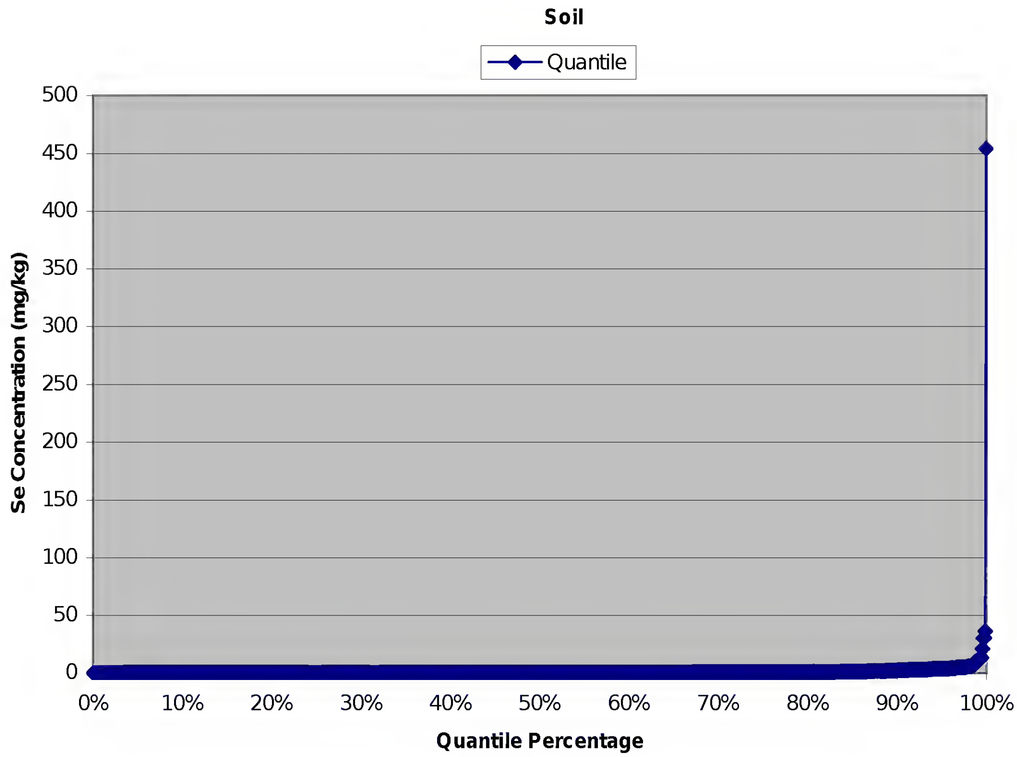


FIGURE 3-3

MULTIPLE FACTOR ANALYSIS QUANTILE PLOT SHOWING HISTORIC SELENIUM RESULTS FOR SOIL ONLY



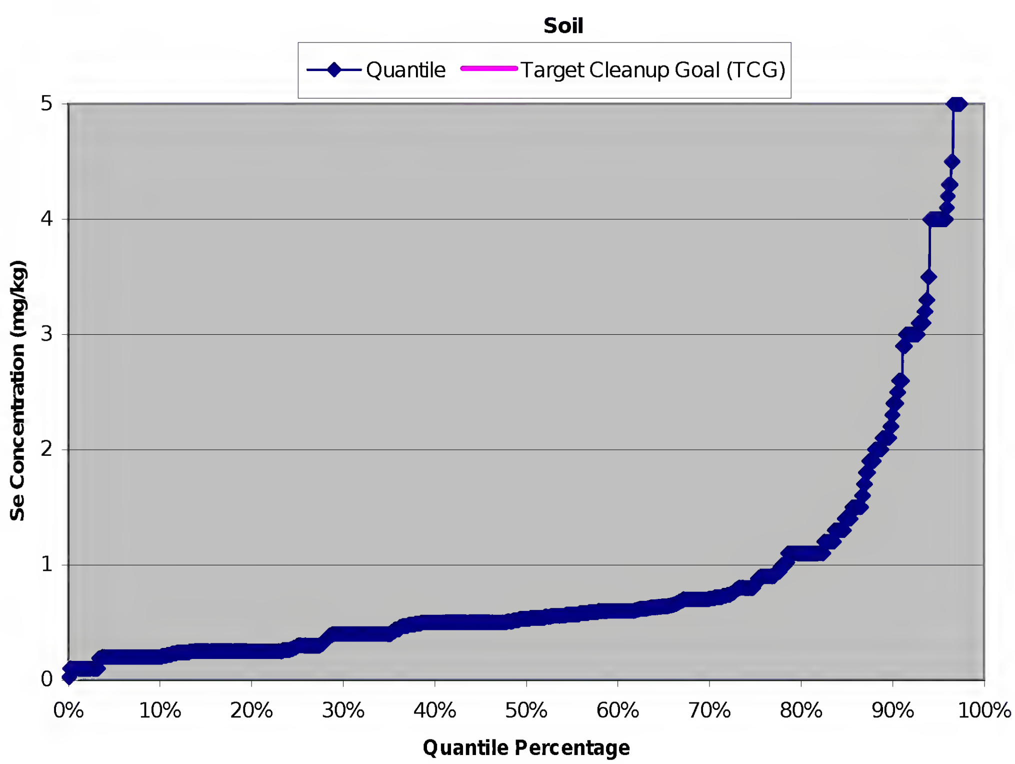
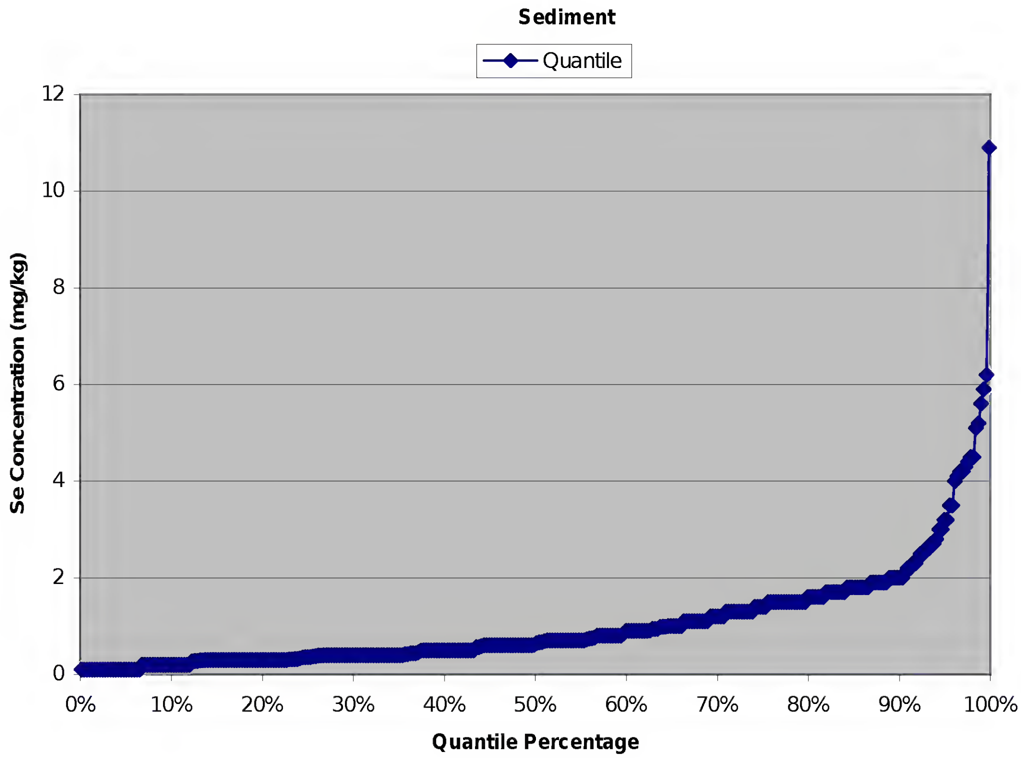
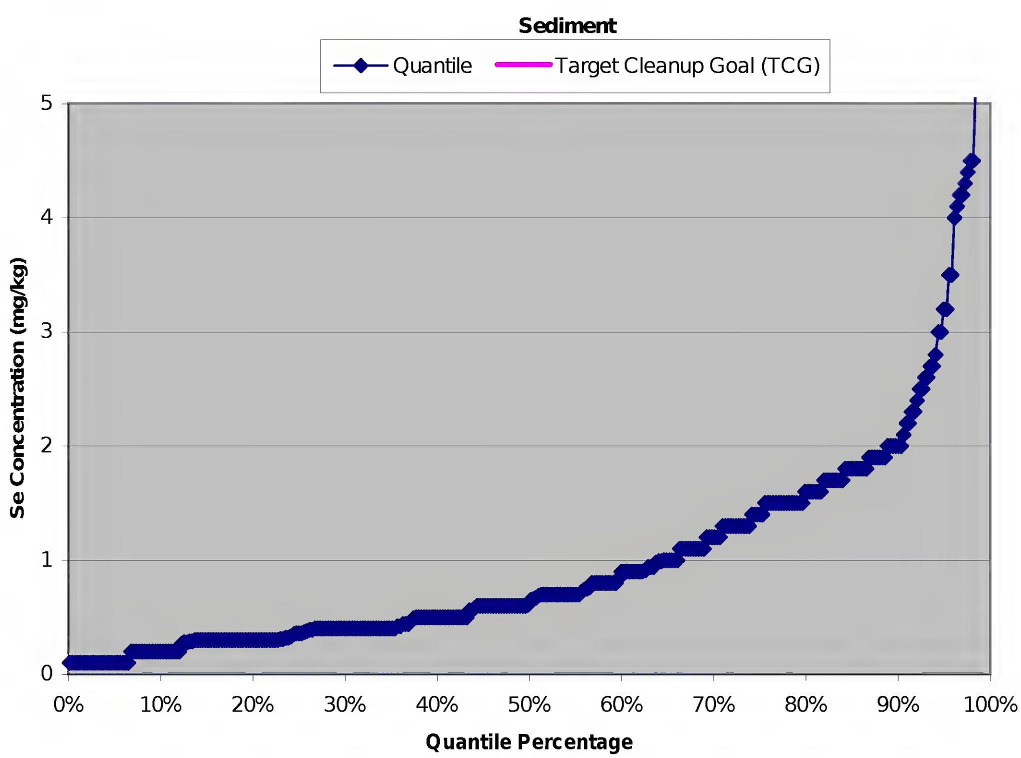


FIGURE 3-4

MULTIPLE FACTOR ANALYSIS QUANTILE PLOT SHOWING HISTORIC SELENIUM RESULTS FOR SEDIMENT ONLY





ATTACHMENT 1

LABORATORY RESULTS

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APPLIED SPECIATION
AND CONSULTING, LLC

953 Industry Drive Tukwila, WA 98188
Tel: (206) 219-3779 Fax: (206) 388-3485
www.appliedspeciation.com

November 22, 2006

Cynthia Heeb
APPL, Inc.
4203 W Swift
Fresno, CA 93722
(559) 275-2175

Project Number: 00-52181

Ms. Heeb,

Attached is the report associated with the six (6) soil samples submitted for total selenium and selenium speciation analysis on November 9, 2006. All samples were received in acceptable condition on November 10, 2006. The following report outlines the applied methodologies for sample preparation, analysis, and any encountered variances.

I appreciate your interest in Applied Speciation and Consulting and look forward to future collaborations. If you have any questions, please feel free to contact me at your convenience.

Sincerely,

Russell Gerads
Vice President
Applied Speciation and Consulting, LLC

Applied Speciation and Consulting, LLC

Report Prepared for:

Cynthia Heeb
APPL, Inc.
4203 W Swift
Fresno, CA 93722

Project Number: 00-52181

November 22, 2006

1. Sample Reception

A total of six (6) clay grab samples in 2oz borosilicate glass jars (not provided by Applied Speciation and Consulting, LLC) were submitted for total selenium and selenium speciation analysis on November 9, 2006. All samples were received in acceptable condition on November 10, 2006 in a sealed cooler at $0.0^{o}C$.

All samples were received in a laminar flow clean hood void of trace metals contamination and ultra-violet radiation. Upon reception, all samples were designated discrete sample identifiers. All clay grab samples were placed in a secure monitored refrigerator, maintained at $4^{0}C$, until extraction for selenium speciation analysis and digestion for total selenium analysis could be performed.

2. Sample Preparation

All sample preparation is performed in laminar flow clean hoods known to be free from trace metals contamination. All applied water for dilutions and sample preservatives are monitored for contamination to account for any biases associated with the sample results.

Total Selenium Quantification of Clay Samples by ICP-DRC-MS Prior to analysis, all clay grab samples for total selenium were digested using a closed vessel HNO_3 bomb digestion. The digested samples were analyzed by inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS).

Selenite and Selenate Quantification of Clay Samples by IC-ICP-DRC-MS Prior to analysis, a homogenous subsample was weighed into a 50mL polyethylene centrifuge tube. A 40mL aliquot of 1.0M K_2HPO_4/KH_2PO_4 was added to each sample and the vials were capped. The samples were then rotated for 24 hours at 80RPM. The slurry

was then removed from the rotator, allowed to settle, and the supernatant was filtered for immediate analysis by IC-ICP-DRC-MS.

3. Sample Analysis

All sample analysis is precluded by a minimum of a five-point calibration curve spanning the entire concentration range of interest. Calibration curves are performed at the beginning of each analytical day. All calibration curves, associated with each species of interest, are standardized by linear regression resulting in a response factor. All sample results are **instrument blank corrected only** to account for any operational biases.

Prior to sample analysis, all calibration curves are verified using second source standards which are identified as initial calibration verification standards (ICV).

Ongoing instrument performance is identified by the analysis of continuing calibration verification standards (CCV) and continuing calibration blanks (CCB) at a minimal interval of every ten analytical runs.

Total Selenium Quantification of Clay Samples by ICP-DRC-MS All sample digests for total selenium quantification were analyzed by inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS). Aliquots of each sample digest are introduced into a radio frequency (RF) plasma where energy-transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially-pumped vacuum interface and travel through a pressurized chamber (DRC) containing a specific reactive gas which preferentially reacts with interfering ions producing different mass to charge ratios (m/z) which can then be differentiated from the target analytes. A solid-state detector detects ions transmitted through the mass analyzer, on the basis of their mass-to-charge ratio (m/z), and the resulting current is processed by a data handling system.

Selenite and Selenate Quantification of Clay Extracts by IC-ICP-DRC-MS All samples for selenite and selenate quantification were analyzed by ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS). Aliquots of each sample are injected onto an anion exchange column and are mobilized by a basic (pH > 7) gradient. The eluting selenium species are then introduced into a radio frequency (RF) plasma where energy-transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially-pumped vacuum interface and separated on the basis of their mass-to-charge ratio (m/z) by a mass spectrometer. A solid-state detector detects ions transmitted through the mass analyzer and the resulting current is processed by a data handling system.

Retention times for each eluting species are compared to known standards for species identification.

4. Analytical Issues

The overall analyses went very well and no significant analytical issues were encountered. All quality control associated with these samples was within acceptance limits with the following exceptions:

It should be noted that the estimated method detection limits (eMDLs) for all selenium species are generated from replicate analyses of the lowest standard in the calibration curve. Not all selenium species are present in preparation blanks; therefore, eMDL calculations based on preparation blanks are artificially biased low.

The total selenium recovery for the matrix spike performed on the sample identified as AX52835 was below the established control limit of 75% (32.2%). All other quality control parameters associated with the digestion reflect acceptable digestion performance and analytical conditions; therefore, the reported results are deemed representative of the associated samples.

The selenite recoveries for the matrix spike and matrix spike duplicate performed on the sample identified as AX52835 were below the established control limit of 75% (9.6% and 12.3%, respectively). An analytical spike and analytical spike duplicate was performed on a similar sample (AX52841) which yielded acceptable recoveries for selenite (115.7% and 116.0%, respectively). Selenite is known to have a greater adsorption affinity in most solid matrices than selenate. The recoveries of selenate and other soluble selenium species in the matrix spikes were within acceptance limits; therefore, the sample matrix is not deemed top induce species conversion. The low selenite recoveries represented in the matrix spikes suggests that the sample matrix induces adsorption of selenite. Since the low selenite recoveries are a function of the sample matrix no further corrective action was necessary.

Two laboratory control samples representing insoluble selenium species (SeS_2 and Se^0) were included in the extraction and analysis of the submitted samples. The recoveries for both insoluble selenium laboratory control samples were 0.0% identifying that the applied extraction procedure does not induce species conversion of insoluble selenium species and is specific to free ionic or weakly adsorbed selenium species.

It should be noted that no selenium species were identified during selenium speciation analysis of clay extract samples which is reflected in the sample results table of this report.

Please feel free to contact me with any questions or concerns regarding any information provided in this report (206) 219-3779.

Sincerely,

Russell Gerads
Vice President
Applied Speciation and Consulting, LLC

Sediment Sample Results for APPL, Inc
Project Name: 00-52181
Client Contact: Cynthia Heeb

Date: November 22, 2006
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Sample ID	Matrix	Collection date	Percent Moisture	Total Se	Se(IV)	Se(VI)
AX52835	Clay	11/7/2006	19.9%	2.51	ND (<0.003)	ND (<0.001)
AX52836	Clay	11/7/2006	21.6%	2.36	ND (<0.003)	ND (<0.001)
AX52838	Clay	11/7/2006	4.5%	1.94	ND (<0.003)	ND (<0.001)
AX52739	Clay	11/7/2006	5.2%	1.31	ND (<0.003)	ND (<0.001)
AX52940	Clay	11/7/2006	18.4%	2.16	ND (<0.003)	ND (<0.001)
AX52841	Clay	11/7/2006	22.1%	2.62	ND (<0.003)	ND (<0.001)

All results are reported in mg/kg and dry weight corrected unless otherwise specified
NR = Not requested
ND = Concentration was below the eMDL. Values are presented as estimated values only.

Sediment Preparation Blank Results for APPL, Inc
Project Name: 00-52181
Client Contact: Cynthia Heeb

Date: November 22, 2006
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Quality Control Summary - Preparation Blank Summary

Analyte (mg/kg)	PBW1	PBW2	PBW3	PBW4	Mean	StdDev	eMDL*
Total Se	0.003	0.003	-0.006	0.002	0.001	0.004	0.013
Se(IV)	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Se(VI)	0.000	0.000	0.000	0.000	0.000	0.000	0.001

*Please see narrative regarding eMDL calculations for selenium speciation analyses.

Sediment Laboratory Control Sample Results for APPL, Inc
Project Name: 00-52181
Client Contact: Cynthia Heeb

Date: November 22, 2006
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Quality Control Summary - Laboratory Control Sample

Analyte (mg/kg)	LCS	True Value	Result	Recovery
Total Se	LCS	5.00	4.84	96.8
Se(IV)	LCS	45.66	43.60	95.5
Se(VI)	LCS	45.66	40.51	88.7
SeCN	LCS	42.67	35.82	83.9
SeS_2	LCS	22300	0.254	0.0
Se^0	LCS	41000	1.156	0.0

Sediment Marix Duplicate Results for APPL, Inc
Project Name: 00-52181
Client Contact: Cynthia Heeb

Date: November 22, 2006
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Quality Control Summary - Matrix Duplicates

Analyte (mg/kg)	Sample ID	Rep 1	Rep 2	Mean	RPD
Total Se	AX52835	2.008	1.899	1.954	5.6
	AX52841*	2.042	2.035	2.039	0.4
Se(IV)	AX52835	ND (<0.003)	ND (<0.003)	NC	NC
	AX52841*	ND (<0.003)	ND (<0.003)	NC	NC
Se(VI)	AX52835	ND (<0.001)	ND (<0.001)	NC	NC
	AX52841*	ND (<0.001)	ND (<0.001)	NC	NC

ND = Concentration was below the estimated detection limit at the applied dilution.
NC = Not calculated due to one or more concentrations below the detection limit.
*Analytical Duplicate

Sediment Matrix Spike/Matrix Spike Duplicate Results for APPL, Inc
Project Name: 00-52181
Client Contact: Cynthia Heeb

Date: November 22, 2006
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Quality Control Summary - Matrix Spike/ Matrix Spike Duplicate

Analyte (mg/kg)	Sample ID	Spike Conc	MS Result	Recovery	Spike Conc	MSD Result	Recovery	RPD
Total Se	AX52835	8.02	4.54	32.2**	8.17	9.70	94.8	72.5
	AX52841*	8.41	11.10	107.8	8.41	11.07	107.3	0.3
Se(IV)	AX52835	35.92	3.44	9.6**	35.92	4.43	12.3**	25.1
	AX52841*	20.65	23.89	115.7	20.65	23.96	116.0	0.3
Se(VI)	AX52835	36.51	38.88	106.5	36.510	40.382	110.6	3.8
	AX52841*	20.65	22.14	107.2	20.65	22.30	108.0	0.7

NA = Data is not available. Please see narrative.
NC = Not calculated. Please see narrative.
*Analytical Spike / Analytical Spike Duplicate
**The recovery is below the established contorl limit of 25%. Please see narrative.

ATTACHMENT 2

RESPONSES TO AGENCY COMMENTS

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RESPONSE TO COMMENTS
FINAL TECHNICAL MEMORANDUM
FOR ASSESSING SELENIUM CONCENTRATIONS
IN THE CLAY REMAINING AFTER EXCAVATION
OF CONTAMINATED SEDIMENTS
DATED FEBRUARY 26, 2008
IRP SITE 27, FORMER NAVAL AIR STATION MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA
DCN: ECSD-2201-0004-0001

Comments dated: April 17, 2008

Comments by: Dr. Beckye Stanton
Staff Toxicologist
Department of Fish and Game
Office of Spill Prevention and Response

SPECIFIC COMMENTS

Comment 1: *The responses to our comments provided by the Navy and associated changes in the revised TM generally address the concerns expressed in our December 20, 2006 memorandum with the exception of the one recommendation made below.*

Response 1: Comment noted.

Comment 2: *Page 3-10, Section 3.2.3, The calculation of the allowable exposure level (AEL) for the Black-necked Stilt included a site use factor that addressed its foraging range relative to the area of habitat estimated for the Northern Channel as shown on Table 2-5 of the final Feasibility Study (FS) (Tetra Tech, 2003). The Text, however, includes additional details regarding foraging and relative habitat quality within each drainage that were not fully documented, detract from the overall discussion, and should be removed. The AELs for other receptors and chemicals and the past remediation were based on the estimated habitat area in the FS and changing the overall concept for only the Black necked Stilt exposed to selenium is not recommended.*

Response 2: Concur. The text will be revised by removing the discussions pertaining to black-necked stilt foraging and relative habitat quality within the drainages.

RESPONSE TO COMMENTS
FINAL TECHNICAL MEMORANDUM
FOR ASSESSING SELENIUM CONCENTRATIONS
IN THE CLAY REMAINING AFTER EXCAVATION
OF CONTAMINATED SEDIMENTS
DATED FEBRUARY 26, 2008
IRP SITE 27, FORMER NAVAL AIR STATION MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA
DCN: ECSD-2201-0004-0001

Comments dated: April 21, 2008

Comments by: Elizabeth Wells, PE
Project Manager
California Regional Water Quality Control Board
San Francisco Bay Region

GENERAL COMMENT

Comment 1: *This letter transmits California Department of Fish and Game (CDFG) comments on the February 27, 2008, Final Technical Memorandum Assessing Selenium Concentrations in Clay Remaining After Excavation of Contaminated Sediments. I concur with CDFG's comments, which are provided in its April 17, 2008, memorandum that is attached to this letter. The Navy must address CDFG's comments prior to finalization.*

Response 1: Comment noted. CDFG's comment will be addressed (see above).

RESPONSE TO COMMENTS
FINAL TECHNICAL MEMORANDUM
FOR ASSESSING SELENIUM CONCENTRATIONS
IN THE CLAY REMAINING AFTER EXCAVATION
OF CONTAMINATED SEDIMENTS
DATED FEBRUARY 26, 2008
IRP SITE 27, FORMER NAVAL AIR STATION MOFFETT FIELD
MOFFETT FIELD, CALIFORNIA
DCN: ECSD-2201-0004-0001

Comments dated:	June 9, 2008
Comments by:	Ms. Yvonne Fong Remedial Project Manager U.S. Environmental Protection Agency, Region IX (EPA)

GENERAL COMMENT

Comment 1: *A Tetra Tech site geologist confirmed via visual inspection that the sediments in the Northern Channel and associated ditches had been removed down to the underlying clay layer, indicating that the Navy has accordingly completed this component of the selected remedy. It appears; however, based on confirmation sampling that there is a notable cluster of selenium concentrations in the North Patrol Road Ditch that exceeds the Target Cleanup Goal (TCG). The area of concern demarcated by confirmation samples is a roughly 700 foot section of the North Patrol Road Ditch west of the Marriage Road Ditch intersection. In Figure 3-1 of the Tech Memo, the western terminus of this area would be the first confirmation sample below the TCG, the 0.95 mg/kg sample that appears to be sample number 04-100. While the Tech Memo provides several explanations for the presence of selenium at a range of concentrations and the confirmation samples indicate that the detected selenium might represent background levels, those samples also indicate that the Navy's remedial action has exposed selenium in the underlying clay layer which may present an unacceptable risk to ecological receptors.*

The ROD selected 0.926 mg/kg as the sediment TCG, a risk-based number for ecological receptors. Consequently, the Navy needs 1) to demonstrate that the selenium exposed by its remedial action in the described area does not present an unacceptable risk to the site's ecological receptors or 2) to perform limited site restoration with acceptable native cover to interrupt the exposure pathway. The Navy can conduct sampling at the ditch bottom-water interface to show that the specific form of selenium present in the area in question is insoluble and not available for uptake by the site's ecological

receptors. Alternatively, sampling to measure the re-emplacement of sediments since construction activities were completed and demobilization activities began in December 2006 may demonstrate sufficient containment of the selenium. If sampling fails to demonstrate that the risk from the elevated selenium concentrations in this area is not a concern, other more active methods of sequestering the selenium could be implemented. The excavation of the channel in this area could be restored with a layer of acceptable native cover to remove the risk.

Response 1: The Navy will perform site restoration in accordance with the Record of Decision (ROD). The Navy understands EPA believes that there are uncertainties regarding ecological risks; however these uncertainties will be eliminated with the Navy's compliance with the ROD. The Navy will submit a letter report that will detail the site restoration activities (type and amount of backfill needed, method of backfill emplacement, standards for backfill, etc.). The Navy will conduct the site restoration activities in the North Patrol Road Ditch once the EPA and Water Board agree with the site restoration approach detailed in the letter report. Following completion of site restoration activities, the Navy will finalize the Remedial Action Completion Report (RACR) that will document the site restoration activities. An Explanation of Significant Differences (ESD) will not be required for the site restoration activities because these activities meet the objectives of the ROD.

SPECIFIC COMMENTS

Comment 1: *The first three sentences of the final paragraph of Section 1.2 should be moved to Section 4.0, (Summary and Conclusions), elsewhere in the Tech Memo, or deleted. These sentences are the conclusions of the Tech Memo and are not the problem statement or the objective of the Tech Memo. The first sentence should also be revised as it is somewhat misleading, suggesting that the ROD addressed the underlying clays when the ROD was merely silent with regard to clays.*

Response 1: Concur. The first three sentences of the final paragraph of Section 1.2 will be deleted.

Comment 2: *It is unclear why a 95 percent confidence interval as discussed in Section 3.0 was calculated for the confirmation samples. Typically, gathering information from an entire data set renders a confidence interval unnecessary. As the sample size increases, the standard error and therefore the confidence interval decreases until, when the entire data set is sampled, the confidence interval equals zero. If the data set mean is known, there is no need for a confidence interval.*

Response 2: The text regarding the 95 percent confidence interval will be removed.

Comment 3: *Section 3.1 states that selenium was not used in any know historical mission at Moffett. However, it appears that the Navy and the Naval Petroleum and Oil Shale Reserves Office conducted large-scale evaluations of oil shale's suitability for use as a military fuel beginning in the 1970s. Selenium is present in oil shale and its waste product. Explain whether or not these Navy activities could have been potential sources of selenium at Moffett.*

Response 3: On April 8, the EPA sent an email to the Navy on this topic. To summarize the email, the EPA stated that (1) the Navy and the Naval Petroleum and Oil Shale Reserves Office (NPSRO) started large-scale evaluations of oil shale's suitability for military fuel in the early 1970s, and (2) Professor Rocco L. Mancinelli, a research scientist at the NASA-Ames Research Center, Moffett Field, was publishing studies on the subject of spent oil shale as early as the 1980s. Spent oil shale can contain elevated levels of selenium, and so EPA suggested that Navy operations related to oil shale that may have been a source of selenium at Site 27. Three references were provided, for review.

The referenced documents were reviewed with respect to assessing whether or not they provide any evidence of large-scale oil shale waste processing that could possibly represent a source of selenium in the Northern Cannel and associated ditches at Moffett. Our findings are summarized as follows:

1. *U.S. Environmental Protection Agency (EPA). 1980. Oil Shale Symposium: sampling, analysis, and quality assurance. Tech. Rep. EPA-600-9/80/022. U.S. EPA, Environmental Research Laboratory, Cincinnati, Ohio.*

This is a 600+ page document which comprises the symposium proceedings. The objective of the symposium was to, "provide a forum for the statement of the state-of-the-art in sampling, analysis, and quality assurance of the oil shale industry pollutants." Opinions from governmental and industrial research organizations were solicited as to the future needs in these areas. Over 40 papers from industry, government, and academic researchers were presented and discussed. The majority fell into four broad categories: (1) regulatory considerations, (2) sampling and analytical issues and strategies, (3) sample characterization, and (4) procedures and methods for assessing toxicity. No references to any large scale disposal of oil shale wastes or related topics were of note. Also, the list of authors was reviewed, and none were from Moffett or the Ames Research Center. Therefore, it is evident from the symposium objective and from a review of the proceedings, that large-scale processing and/or deposition of oil shale wastes was not addressed, and this document provides no evidence of a link between such activities and selenium present at Site 27.

2. *Andrews, Anthony. 2006. Oil Shale: History, Incentives, and Policy. Congressional Research Service Report for Congress, Library of Congress. Order Code RL33359, CRS.*

This document was generated by the Congressional Research Service in light of the fact that increasing oil prices have revived interest in oil shale as a resource. The document has four major components: (1) a general overview of geology and oil shale production technology, (2) a history of oil shale development, (3) plusses and minuses regarding development of this resource, and (4) issues related to policy. Of these, the history of oil shale development is of potential interest. Basically, during WWII, the U.S. Bureau of the Mines operated experimental production facilities in Colorado.

In addition, other efforts were briefly undertaken by private industry, but all were in Colorado as well. Large-scale DOD evaluations of oil shale's suitability as a military fuel began in the early 1970s, but production activities were conducted in Colorado, Ohio, and Utah. The DOE also "encouraged" interest in oil shale production via several avenues, but all production facilities were located in Colorado. There are no references to Moffett or to the Ames Research Center in the document, and based on the information presented, there is no reason to associate oil shale production or waste disposal activities with Site 27.

3. *Segal, William and Mancinelli, Rocco L. 1987. Extent of Regeneration of the Microbial Community in Reclaimed Spent Oil Shale Land. J. Environ. Qual. 16: 44-48.*

This is a peer-reviewed research paper describing laboratory studies that were conducted to ascertain the effects of spent oil shale land on microbial numbers and diversity. The work was intended to yield information regarding toxicity and biodegradability of spent oil shale.

The paper states that processed oil shale bore samples (6-cm diam x 10-cm deep) were collected from four sites in Colorado and Wyoming, and placed in plastic bags and sent to the laboratory. The experimentation basically involved microbial enumeration of the samples using the plate count technique on several types of agar, which requires minute amounts of sample material. The location of the laboratory is not given, but the author is identified first as a Professor of biology at the University of Colorado, and second as a scientist at NASA-Ames Research Center at Moffett Field.

Finally, the work was funded by the Colorado Energy Research Institute. From this information, it appears that, (1) only a small amount of spent oil shale material is involved (likely only a few pounds), and (2) although not clear, the work was likely conducted at the University of Colorado. However, even if the work was conducted at Moffett, it is implausible that the laboratory samples are related to

selenium detected in sediments and clays in the Northern Channel and associated ditches.

In summary, the documents referred to by EPA do not reveal any information that would suggest a link between activities related to spent oil shale and the selenium detected at Site 27.

Comment 4: *Additional information is needed to explain the relevance of the referenced background selenium concentrations discussed in Section 3.1.1. Coast Range soils and rocks are highly variable and it is unclear if the Guadalupe River results are appropriate for comparison to Site 27.*

Response 4: This section is intended to establish that selenium occurs naturally in soils and is known to be present in local and regional soils within the vicinity of Moffett at comparable concentrations. Since the Northern Channel and associated ditches have received runoff from the area for decades, it is plausible that this may be the source of elevated selenium levels in sediments, and that the selenium in the underlying clays is most likely naturally occurring. The text will be modified to clarify these points in Section 3.1.

Comment 5: *Section 3.1.2 should be deleted. The origin of the materials in the debris pile is unknown and the presence or absence of selenium in the debris pile does not provide a comparable or reliable point of reference for the sediments or clays in the ditches. While the measured concentrations of selenium in the debris pile may be similar to those in the ditches, the findings do not preclude the possibility that the selenium in both areas was the result of Navy operations.*

Response 5: The Navy prefers to retain this section. Additional text will be added to explain and/or reiterate that selenium was not used in any known historical mission at Moffett, the samples collected from the debris pile area consisted of the same clay that is present in the channel/ditches, the area is not affected by runoff, and that the debris consisted of construction debris (mostly rock, roofing, concrete, and wood). Further, this was not a chemical waste disposal area. In a total of ten clay samples collected from the debris pile, only one COC other than selenium (a PCB) was detected in only one sample (DDT, DDE, DDD, chlordane, six other PCBs were not detected, and the five other metals of interest (mercury, lead, silver, cadmium, and zinc) were either not detected, or were detected at levels well below soil and sediment TCGs. Therefore, it is reasonable to conclude that the debris pile samples do provide a comparable reference point for the clays in the channel/ditches.

Comment 6: *Section 3.1.4 should be deleted. The Tech Memo states that research shows that selenium has been shown to accumulate in sediments in reducing environments such as wetland channels. This may be true in the cited case but the Navy did not collect and analyze samples from the sediment/water interface to determine the actual redox potential of the surficial sediments. The samples collected at 12 and 18 inches bgs would naturally be reduced and not representative of the surficial sediments to which ecological receptors would be exposed.*

Response 6: This section will be revised to clarify that the speciation analysis was not conducted on the surface clay samples and, although likely, it can not be definitively concluded that the selenium in the surface clays is present in insoluble forms. The Navy will also provide additional discussion explaining why it is not likely that selenium in surficial clays is in a soluble form.

The discussion will also be revised to focus on the fact that selenium was found to be present at depth in the clays (up to 18 inched deep), at concentrations comparable with those detected in the confirmation samples collected at the clay surface following sediment excavation. This supports the assertion that it is likely to be a natural constituent of these clays.

Comment 7: *Section 3.2 should be deleted. The cleanup level of 0.926 mg/kg was developed in a risk assessment and selected in the Site 27 ROD. If the Navy does not wish to produce a new ecological risk assessment and amend the ROD, this section which attempts to undermine the existing risk assessment should be removed from the Tech Memo. Furthermore, the site use factor for the black-necked stilt should be removed as it is based on a qualitative description of the habitat available for foraging which is different from the habitat assumptions used before the Final Feasibility Study.*

Response 7: Section 3.2 is not meant to undermine the existing risk assessment but to augment the risk assessment using site specific information. The Navy believes that it's our responsibility to include an evaluation of the risk at the site using site specific data. The Navy will revise Section 3.2 to clarify that the purpose of this section is to provide a more realistic evaluation of risk at the North Patrol Road Ditch but is not meant to replace the existing risk assessment.

The site use factor and habitat quality discussion for black-necked stilt will be deleted from the Tech Memo.

MINOR COMMENTS

Comment 1: *The first paragraph of Section 3.0 includes two contradictory statements regarding the number of confirmation samples collected from the Northern Channel. Correct the later statement to state that "However, 57 of the 200 samples from the Northern Channel…"*

Response 1: Concur. The contradictory statements will be rectified.

Comment 2: *In Section 3.1.3, Item number 5 contains a couple minor errors. The results "were mostly in the range of 2 to 3 mg/kg. The concentrations reported as non-detected with a reporting limit above the cleanup level of 0.926 mg/kg were filtered out."*

Response 2: Concur. The minor errors will be corrected.

Comment 3: *The terms "Grouping" and "N" in the table in Section 3.1.3 should be explained.*

Response 3: Concur. Explanations will be provided in the table as requested.

Comment 4: *Section 3.1.3 references Figures 3-2, 3-3 and 3-4. Explain the titles of these figures (e.g. MFA Quantile Plots). Also, add the vertical bar that represents the cleanup goal in these figures.*

Response 4: Concur. Explanations/additions will be added to the figures as appropriate as requested.

Comment 5: *In the last sentence of Section 3.1.3, the abbreviation for selenium, "Se," should be replaced with the whole word.*

Response 5: Concur. The requested edit will be made.

Comment 6: *Section 3.1.5, Summary, seems to be logically misplaced. The section would be more appropriate immediately following Section 3.1.3 or in Section 4.0.*

Response 6: Concur. The requested edit will be made.